A FIELD OF MARQUIS WHEAT.

CROP PRODUCTION

IN

WESTERN CANADA

BY

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PREFACE

Important as crop growing is in Western Canada, no effort has heretofore been made to gather together a summary of the experiences of the pioneer farmers and the results of carefully conducted tests in crop growing within the confines of one book. The chapters that follow constitute an attempt to bring within reasonable space an outline of the cropping practices now followed by the leading farmers in many parts of the West, together with a discussion of the purposes of these practices and suggestions for modification of them where soil and climatic conditions demand a different procedure.

The work is largely a revision of addresses delivered at farmers' gatherings during the past twelve years, and of lectures prepared for the associate students in Agriculture at the University of Saskatchewan. The book is offered to the crop growers of Western Canada in the hope that it may prove useful to the men now on the land, as well as to the large number who, in the next few years, will come to make their homes on farms in the Prairie Provinces.

The writer desires to express his appreciation of the assistance rendered by many associates and friends in the assembling of this work. To those who are now, or who have in the past been associated with him, his greatest thanks are due. Among these are L. E. Kirk, B.S.A., Instructor in Forage Crops; A. E. Henry, B.S.A., Instructor in Cereals; John Cameron, B.S.A., formerly Assistant in Field Husbandry; Henry Saville, B.S.A.,

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CROP GROWING IN WESTERN CANADA

General.

1. The Importance of Good Seed.
2. The Choice of Crops.
3. The Principles Underlying Plant Growth.

Culture of Crops.

4. Wheat, the Chief Cereal of the Open Plains.
5. Oats, the Cereal of the Park Belt.
6. Barley, the Feeders' Grain.
7. Rye, the Grain of Hardiness.
8. Flax, the Oil and Linen Plant.
9. Peas, the Crop of Quality.
10. Forage Crops, the Crops of Permanence.
11. Root Crops, Nature's Provision for the Health of Stock in Winter.
12. Potatoes, the Cheapest Human Food.
13. Corn, a Dry Farm Fodder for the Warmer Parts.

Enemies of Crops.

14. Insect Enemies of Field Crops.
15. Diseases of Potatoes.

CONTENTS

CHAPTER X.

CHAPTER XI.

CHAPTER XII.

CHAPTER XIII.

CHAPTER XIV.

CHAPTER XV.

LIST OF ILLUSTRATIONS

TABLES AND CHARTS IN APPENDIX

CROP PRODUCTION
IN
WESTERN CANADA

Crop Production

CHAPTER I

THE IMPORTANCE OF GOOD SEED

The three Prairie Provinces use annually almost 40,-000,000 bushels of seed grain. In faith, the farmer sows this seed on approximately 25,000,000 acres of our best soil. A crop of 600,000,000 bushels, which is about 80 per cent. of the total wealth produced annually in these provinces, is for four months every year locked up in the possibilities of this seed. If it produces abundantly the population lives in plenty; if it yields fair returns but few people are seriously inconvenienced; if it fails the mechanism of commerce suffers and the inefficient producer feels the pinch of poverty.

Grain farming, more than most types of agriculture, carries many risks. The extent to which these can be removed, or controlled, or lessened, is a measure of the success of the farmer. One of the chief factors upon which the profit of the harvest depends, and one which always affects the yield and quality of the crop and sometimes is the cause of complete failure, is the character of the seed sown. The nature and function of seeds is now well understood and the characteristics of good

seed are well known. When inferior seed is the cause of poor crops man alone must bear the responsibility, since among all the essential factors of production, this is one that is wholly within man's power to control.

1. What a Seed is.—A seed may be defined as one of nature's provisions for carrying forward the life of a plant from one generation to the next. It is a dormant stage in the life history of a plant—a means of carrying a race of plants through an untoward season such as our winter.

Every seed consists of at least four very important parts—(1) the embryo or germ or miniature plant, (2)

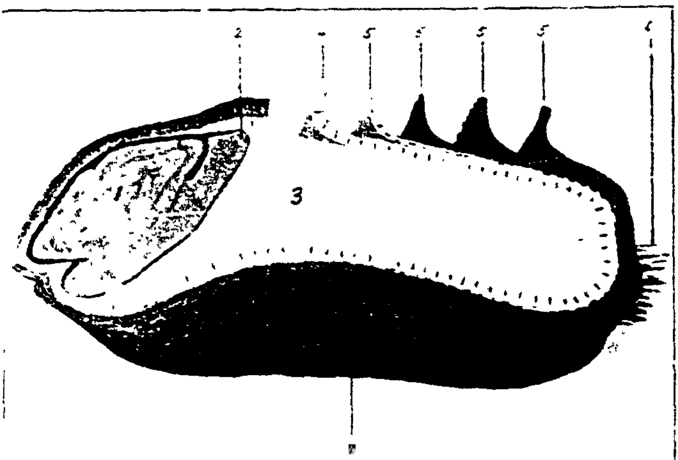

Fig. 1.—Longitudinal Section Through Wheat Seed.
Showing (1) embryo, (2) scutellum, (3) endosperm, (4) aleurone layer, (5) layers of the bran, and (6) the "brush".

a supply of food material for the little plant, (3) a part containing a ferment or enzyme for making the plant food in the seed "available" to the plant within it, and

(4) a protective covering. Each of these is clearly shown in Fig. 1.

2. The Function of the Different Parts of a Seed.—The function of the embryo is to carry the "life principle". Our common domestic plants do not originate spontaneously, but develop from embryos—small immature plants—found in seeds. A germinable seed is not dead—it is only dormant. The embryo is a miniature plant so preserved and protected that it can withstand adverse weather conditions and yet spring into growth when favorable conditions are provided.

The storehouse of plant food, called "endosperm" in wheat, consists of organic compounds placed there by the parent plant for the use of the embryo when it starts to grow. Its function is to provide food for the little plant until such time as the latter can get its supply elsewhere. Obviously the more plump the seed is, the better it is matured, and the less it is injured, the better it can nourish the young plant and the better the yield is likely to be.

The plant food in the seed is generally stored in a relatively "insoluble" or unavailable form like starch, for the reason that it will keep much better in this condition. But before the embryo can draw upon it for nourishment, the plant food must be made available. To accomplish this purpose the parent plant has provided substances known as enzymes, or ferments, which when the embryo is about to germinate, change the plant food from an insoluble to a soluble condition. These substances are found in the "scutellum" of the seed of wheat. They function only when the temperature and moisture conditions are such as favor growth or germination.

The outer covering, or bran, consisting in wheat of several layers, is a provision of nature for protecting the little plant and its supply of nourishment from unfavorable conditions, such as moist weather, fungus diseases and mechanical injury.

3. Germination.—When a seed changes from a "dormant" to an "active" state it is said to germinate, or sprout. This change is caused by three conditions, each of which is absolutely necessary before the change can take place. These conditions are, moisture, heat and air. When a dormant seed is brought into contact with moisture, heat and air, each in the right amount and at the same time, germination takes place. If only moisture and heat are present it will start to sprout, but eventually die, while if only moisture and air, or heat and air, are present the seed will remain dormant. All three are essential for germination. All three are necessary to cause the enzymes

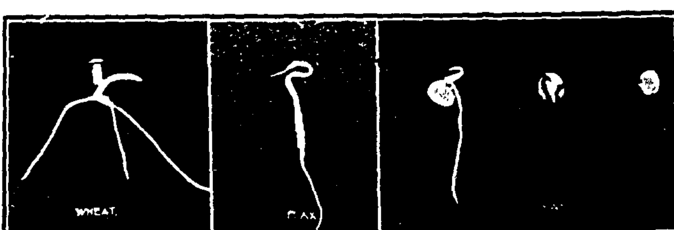

Fig. 2.—Wheat, Flax and Peas Germinating.

or ferments in the scutellum to become active and thus make the plant food of the endosperm "available" for the embryo.

We make use of these fundamental principles when we test seed for germination, as well as when we plant seeds in the soil. In the germination test we control the

amount of moisture, heat and air by artificial means. When we sow seeds in the field we have only limited control of these conditions, hence our best judgment should be exercised in preparing the soil, in order to have it in such tilth that when sown at the right depth the seed will find the conditions necessary for germination, *viz.*, moisture, heat and air.

4. The Characteristics of Good Seed of any variety are strong vitality and high purity. Vitality is measured by the germination test. It is expressed in the percentage that will grow and in the vigor of the growth. It is evidenced by the soundness, plumpness and lustre of the sample. The purity is estimated by counting the number of weed seeds and other classes and varieties of seeds per ounce or per pound and by examining the sample for evidence of disease.

5. Some Common Defects in Seed.—The most common defects found in seed grain are:

(1) Weed seeds.
(2) Disease.
(3) Small and shrunken seeds, or seeds of weakened vitality.
(4) Dead grains, and
(5) Unsuitable varieties.

The weed seeds most often found in wheat, oats and barley are wild oats, cockle, wild buckwheat and ball mustard, but in poorly cleaned or uncleaned samples many others may be found. In flax, blue burr, hare's ear mustard, wild mustard and false flax are the most common impurities. In western rye grass and brome grass, wild oats, blue burr and quack grass are often present, while in the small hard seeds like timothy, clover

and alfalfa, many species of mustard and some of thistles and other weeds are common impurities.

Samples of seed wheat containing 2,880 wild oats per bushel, of seed oats containing 13,000 wild oats, and of seed flax containing over 30,000 weed seeds of seven different species per bushel have been brought to our attention, while the Dominion Seed Analyst reports some samples of timothy containing 10,000 weed seeds per ounce. The Dominion Seed Control Act permits in its No. 3 grade as much as 40 noxious and 360 other weed seeds per ounce, in timothy and alfalfa. The No. 1 seed of wheat, oats and barley distributed by the Dominion Seed Grain Purchasing Commission in 1918 was permitted to have one noxious weed seed per pound, while No. 2 seed might have 10 per pound.

From these observations it is very apparent that all of us should examine very carefully the seed that we are about to sow. Many of the impurities mentioned cannot easily be removed from some of the classes of seed, but practically all can be taken out of wheat, and most can be taken out of any seed by careful cleaning.

The smut diseases cause much loss annually to Western farmers. These fungus plants not only lower the yield of crops, but the quality as well. If living smut spores (which function as seeds) are sown with the seed, the crop is sure to be infected.

Small, shrunken or weak seed produces weak plants that are less productive and much less likely to withstand spring frosts after the plants are up. This is where the chief danger lies in using grain from a rusted or immature crop.

Frost often kills the seed of oats, while heating frequently destroys the vitality of wheat and other grain.

It is always wise to test the seed for both percentage and vigor of germination. This is particularly advisable after a season when early fall frosts have been known to occur as well as in cases where dampness or heating in the bin have been suspected.

A considerable proportion of the western crop is grown from varieties that are not the best suited to our soil and climatic conditions. There are still many persons using inferior sorts where better paying ones might be grown. The use of unsuitable varieties is the least pardonable and often the most costly of the common errors of the newcomer to the West.

6. The Best Varieties of all classes of crops are indicated in Secs. 34 to 45 and a discussion of the relative suitability of the different varieties to different conditions in the West is left for consideration in subsequent chapters. It may be found in the following sections: Wheat varieties, Sec. No. 83 to 90; oats, 138 and 139; barley, 166 and 167; rye, 185, 186 and 191; flax, 201; peas, 224 and 225; grasses, 246 to 253 and 285; alfalfa, 256 and 264; clover, 274 and 275; roots, 310 to 317; potatoes, 334 and 335, and corn varieties in Sec. 364.

7. The Value of the Fanning Mill.—In a carefully conducted test recently completed the large, plump seed removed by hand from a sample of No. 1 Northern wheat produced 4 bushels 47 pounds more than the small, shrunken grain the sample contained. The fanning mill does not make as good a separation as this, but the average increase from seed graded with a mill was 49 pounds more than from the ungraded, and 2 bushels 26 pounds more than from the small seeds removed. (94).

A good fanning mill, properly handled, removes, in addition, weed seeds, smut balls and many of the dead

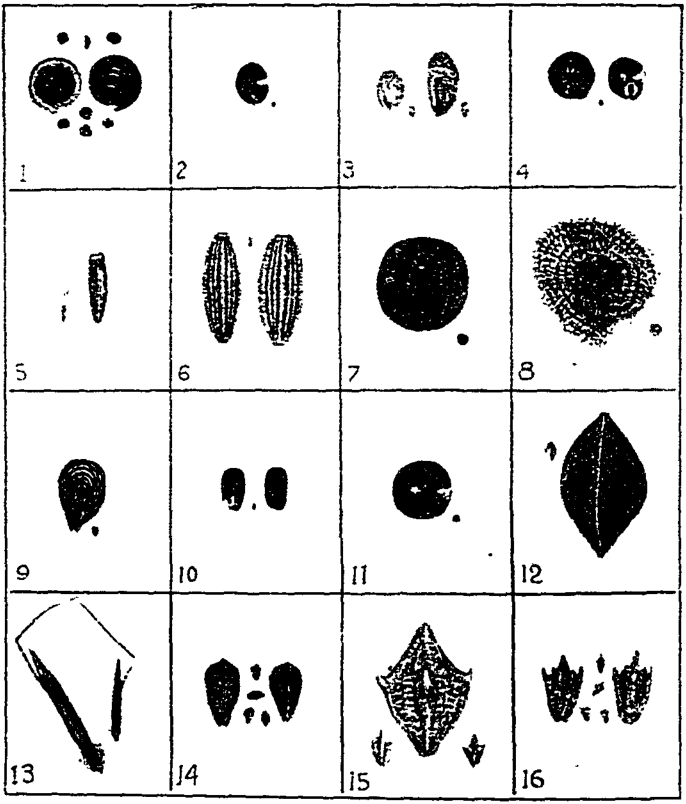

Fig 3.—Weed Seeds Commonly Found in Western Grain.
1 Russian Thistle 2 Red Root Pigweed 3. Russian Pigweed 4 Lamb's-quarters 5 Canada Thistle. 6. Field Sow Thistle. 7. Cow Cockle 8 Purple Cockle 9 Stink Weed. 10. Tumbling Mustard 11 Wild Mustard 12 Wild Buckwheat 13. Wild Oats 14. Poverty-weed 15 Tall Ragweed. 16. Common Ragweed.

and weakened grains. In seasons when much of the grain is shrunken or frosted, and some of the seed damaged, impure, or dead, the use of the fanning mill is essential if the best results are to be obtained.

If one were to take half an hour and count out the

weed seeds and diseased grains in a pound of the grain to be sown, and then take steps to improve the seed as much as its condition requires and the facilities at one's disposal permit, there is little doubt but that such a half-hour would prove to be much more profitable than any ten that might later be spent in producing the crop.

A sample of "cleaned" wheat containing at the rate of 1,920 wild oats per bushel (16 per one-half ounce) recently came to hand, with the request that we advise the sender whether he should get a new fanning mill or not. Another sample taken from a grain drill contained 7 smut balls, 226 wild buckwheat, 2 wild mustard, 2 ball mustard, 12 lamb's quarters, 1 blue burr, 2 docks, 1 hare's ear mustard, 1 barley and 8 oats in a single pound. Every bushel sown placed sixty times these numbers on the land. And yet practically all could have been removed with a fanning mill.

8. The Germination Test.—It is important that the crop producer know not only the proportion of his seed that will grow, but also the vigor of the possible growth. A box of moist soil, or two layers of dampened blotting paper, will enable him to determine these points. It is only necessary to count out a number of seeds, usually one hundred, and after planting them in the soil or placing them between the blotters, keep them moist and at the temperature of the ordinary living-room and count the number that germinate. The blotting paper method is satisfactory for getting the percentage germination, but the soil method is preferred where the relative vigor of growth is desired.

From such a test one will gather an accurate idea of the percentage germination and the relative vigor of growth of the seed he is about to use. The best seeds

will germinate first and develop the most vigorous plants, while the poorer seeds will either not grow at all or pro-

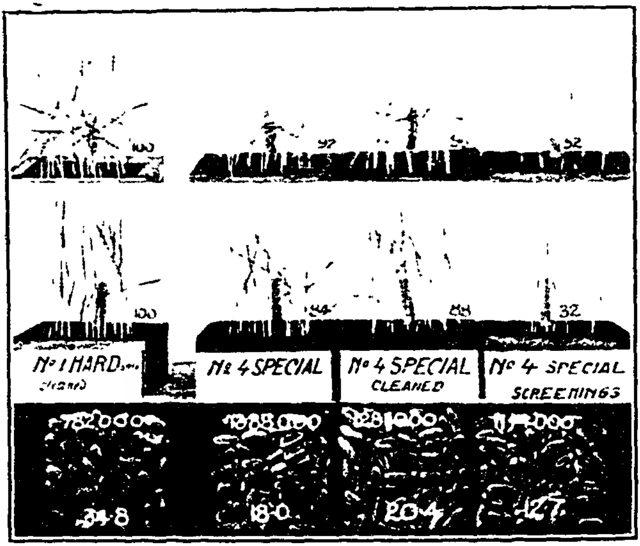

Fig. 4.—Germination Test of Wheat Seeds.

Showing at bottom the character of the seed tested, in the middle row the number of plants that grew and the vigor of growth nine days after planting and at top the number that grew and the vigor of growth sixteen days after planting in sand. The figures in white represent (at top) the number of germinable seeds per bushel and (at bottom) the weight of 1000 kernels in grams. Note the low percentage germination and the low vigor of growth in the right hand sample. Note also the high number of germinable seeds per bushel in spite of the low percentage germination.

duce only a feeble growth. Of course, the seed under test should be protected from frost, and kept from drying out.

9. The Formalin Treatment for Disease. The formalin treatment, when properly applied and used annually, will control the covered smuts of wheat (123), oats and barley, and the loose smut of oats, provided infection from "smutty" bags or other containers after treating, is prevented. It will also aid in the control of flax wilt.

Formalin is a trade name for a 40 per cent. solution of formaldehyde. One pound (16 ounces) of this solution, stirred in forty imperial gallons of water, gives the proper strength for treating cereal grains. The seed may either be "dipped" in this solution, or it may be put in a pile on the floor and "sprinkled" with it.

Given the right strength of solution, only two other things are essential to kill the spores: (1) the unbroken smut balls must be removed either by the fanning mill or by "floating" them off the surface of the liquid—the solution will not penetrate to the centre of an unbroken smut ball, hence this precaution must be taken to remove them—and (2) the entire surface of each seed must be moistened or subjected to the escaping vapor of the formalin.

If the seed is "dipped" it should not be left in the solution for more than four or five minutes before being removed and spread out to dry. If the grain is "sprinkled" about one gallon per bushel should be used. As the solution is being applied, the grain should be shovelled or turned over and over in order to secure as uniform and thorough a moistening of the whole surface of each grain as possible. After sprinkling with formalin the grain should be heaped up in a pile and covered with bags or blankets for about three hours in order to insure that any unmoistened portions of the seed are subjected to the influence of the escaping formalin vapor. The pile should then be uncovered and spread out thinly to dry.

In treating flax, the sprinkling method should be used. A very fine spray is preferred and the seed should be stirred continually as the liquid is applied. All other operations are similar to those followed in treating wheat, with the exception that the flax must be raked over

occasionally as it dries in order to prevent the seed "caking" or clinging together in lumps and thus causing trouble in the drill.

10. The Bluestone Treatment will control the covered or stinking smut of wheat, but is not satisfactory for the smuts of other crops nor for flax wilt. If this treatment is to be used, five pounds of the commercial quality copper sulphate should be dissolved in fifty imperial gallons of water, by suspending it in a bag for a period of eight to twelve hours in a barrel of water. With bluestone, either "dipping" or "sprinkling" may be practised. The same care should be taken to remove smut balls and to insure the wetting of the whole surface of all seeds. If the seed is "dipped" it ought not to be left in the solution for more than two or three minutes, when it should be removed and spread out in a thin layer to dry.

11. Precautions Necessary in Using Formalin and Bluestone. The strength of the solution used should be neither greater nor less than that given above. The seed should not be allowed to freeze hard while wet, nor to remain damp for too long a period, or the vigor and germination will become impaired. Generally speaking seed grain should not be treated very long before it is sown. In actual practice treating the day before it is needed is the common rule; the longer it is left unsown after being treated, the less vigorous the germination is likely to be. This is particularly true if bluestone is used. The formalin treatment may be given some time before seeding *if the seed is thoroughly dried afterwards.* Every care should be exercised to see that "treated" grain is not reinfected by being handled in smut infected bags.

Treating grain increases its bulk 5 to 25 per cent., depending upon the amount of solution used and how

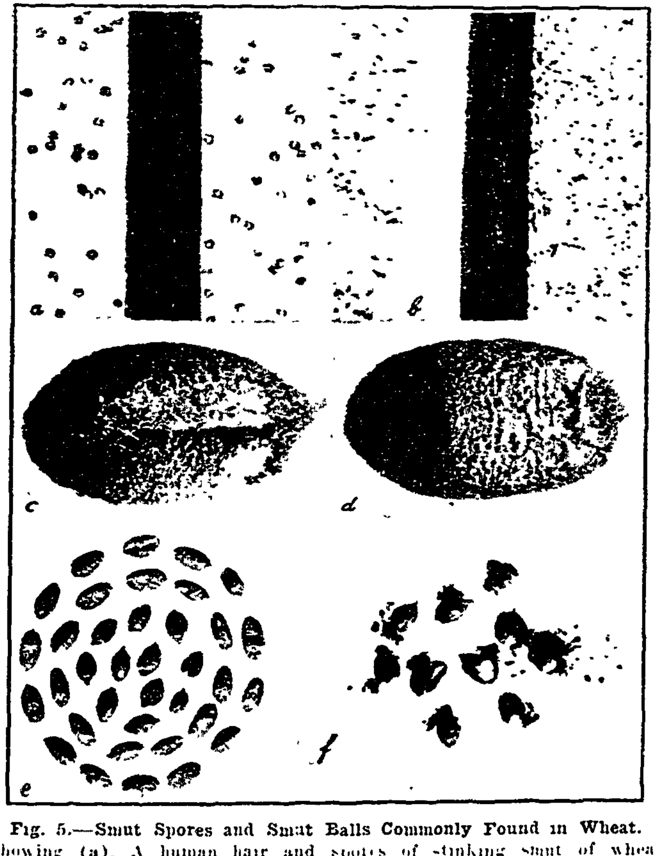

Fig. 5.—Smut Spores and Smut Balls Commonly Found in Wheat.
Showing (a). A human hair and spores of stinking smut of wheat enlarged. Eight smut spores placed side by side measure the breadth of a hair. (b) A human hair and spores of loose smut of wheat of which 19 placed side by side would measure the breadth of a hair (c) Lower surface of wheat grain showing "groove" and "hairy end"; (d) Upper side of same grain showing surface "wrinkles", both enlarged (e) The outer two rows are sound grains of wheat in the centre 11 "smut balls" showing the appendages; natural size (f) A number of smut balls crushed; the black masses consist of millions of spores (By courtesy H. T. Gussow)

much it is allowed to dry out before seeding. Allowance for this should be made when sowing.

12. Smut Machines.—Many machines for the treatment of grain for disease are on the market. They are good in so far as they facilitate the speed of the operation and at the same time insure the wetting of the entire surface of each seed. The suitability and durability of the various makes is usually not difficult to estimate.

13. The Hot Water Treatment will control all the smut diseases of cereals, but it is very laborious and time-consuming. It is only advisable for the smuts the other treatments will not control, *viz.*, the loose smuts of wheat and barley. In Bulletin No. 73 of the Division of Botany, Central Experimental Farm, Ottawa, the hot water treatment for loose smuts of wheat and barley is outlined as follows:

"Preliminary Treatment.—Bring the temperature of a quantity of cold water in a barrel or tank up to 86° F., pouring in hot water until the thermometer registers 86° F., and not more or less. Use a reliable thermometer. Fill a grain bag three-quarters full with grain and tie it up loosely. Immerse bag with grain into this water, moving it up and down several times. Allow grain to soak four hours. Should the temperature sink below 68° F. allow five hours for soaking. Treat preferably in a heated room to avoid the inconvenient fall in temperature of the water.

"Final Treatment. Bring the temperature of water in a second barrel up to 112° F. Remove bags of grain from the "soak" and transfer to the second barrel. Keep immersed for 15 to 20 minutes. Meanwhile, have hot water in a third barrel brought to a temperature of 129° F. After 15 or 20 minutes in the second barrel, transfer the grain quickly into the third barrel. Here

the grain remains a further 10 minutes. Under no circumstances extend the time stated, or shorten it. Neither be careless nor disregard accuracy of temperatures, or the treatment will not be successful. Should the temperature in the third barrel sink below 122° F. after the grain is put in, raise the temperature by carefully adding hot water from a sprinkling can. Never pour hot water directly on the grain. The larger the volume of water the more easily the temperature may be maintained. After the 10 minutes in the third barrel have expired, take out the grain, drain and spread out to dry."[7] (See also Sec. 172).

14. The Time to Plant Seeds.—Seeds are planted in the expectation that they will grow. In this climate the

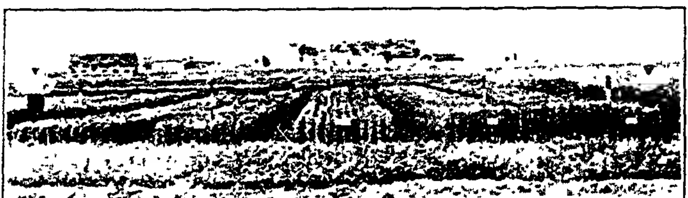

Fig. 6.—Experiment in Dates of Seeding.
Crop sown at each of five different times in the spring to find out the best time to sow.

temperature conditions at the time of planting, and the probable frost damage after the seedlings are up and before the plants mature in the fall, largely determine the best time to plant.

Early seeding is desirable (1) in all areas subject to early fall frosts, (2) on fallowed land, (3) on rich, productive and heavy soils, and (4) with all late maturing crops. Later seeding is permissible (1) in areas where early fall frosts or August drought seldom do damage

to the crops, (2) on light warm soils, (3) on fall or spring plowed or stubble fields containing little moisture, and (4) with all early maturing crops.

In the year 1914 the earlier than normal seedings gave the best returns. In 1915 and 1918 the later than normal seedings yielded most. The year 1914 was characterized by no late spring frosts and by extreme summer drought, very little moisture falling between seed-time and harvest. In the year 1915, on the other hand, all crops were frozen back as late as June 20th, the summer was very wet and the autumn frosts did not come until late. In 1918 the early summer was extremely dry, while the late summer was more moist—the early varieties were forced to ripen prematurely, while the later ones benefited most by the late rains.

Conclusive data on the subject of time of seeding in many parts of Western Canada are not yet available. The following table indicates the results of trials at Saskatoon carried on during the last four years:

	Best time to sow	Range of suitable dates to sow
Wheat	April 15 to 30	April 10 to May 20
Oats	April 30 to May 10	April 20 to May 20
Peas	April 25 to May 10	April 25 to May 15
Barley	April 30 to May 20.	April 20 to May 30.
Rye—Winter	Aug. 20 to Sept. 5	Aug. 10 to Sept. 20.
Rye—Spring	April 30 to May 10	April 10 to May 30.
Flax	May 10 to 20	April 30 to May 30.
Potatoes	May 10 to 20.	April 30 to May 30.
Rape	April 30 to May 10.	April 30 to June 10.
Carrots	April 30 to May 10	April 30 to May 30.
Mangels	May 10 to 20	April 30 to May 30
Swedes	May 10	May 10 to 30.
Corn	May 20 to 30	May 10 to June 10.
Grasses	Early in June if sown alone, otherwise in spring with nurse crop.	
Clovers	Early in June if sown alone, otherwise in spring with nurse crop.	
Alfalfa	Early in June	

The above conclusions are not necessarily applicable over the whole West, but, if allowance is made for differences in climatic conditions in the different sections, they should at least be found very suggestive.

The best time to sow in any given district varies with:

(1) The probability of early fall frosts—the greater the danger, the earlier the seeding should be done.

(2) The amount of water stored in the soil—the drier the soil, the earlier the crop will mature and, therefore, the later it may be sown and yet avoid frost.

(3) The productiveness of the soil—the more rank the growth, the longer the crop will take to ripen, hence the earlier it should be sown.

(4) The type of soil—a heavy soil is a cold soil, a light soil a warm one. Crops ripen later on heavy soils and, therefore, need to be sown earlier.

(5) The time required to mature the class or variety of crop used. Under normal conditions barley and rye ripen sooner than oats and flax, and these sooner than wheat or peas, while in each of these classes there may be found early and late varieties. Obviously the late-ripening ones should be sown first unless they are too tender to withstand spring frosts.

(6) The resistance of the crop to spring frosts. The less frost a crop will withstand in the spring the later it should be sown. If good seed is used, most cereals will survive after heavy spring frosts, but it has been observed (1) that wheat and rye are somewhat more resistant to low temperatures than

oats, (2) that oats are rather hardier than barley, and (3) that flax is considerably more tender, at least when very young, than any of the cereals.

(7) The liability of the district to hot winds in late summer—the greater the danger, the sooner the crop should be sown.

15. The Amount to Sow.—The amount of seed that should be used under any given set of conditions seems to vary with—

(1) The kind of soil, whether heavy or light.

(2) The preparation, whether fallow, breaking or stubble.

(3) The time of seeding, whether early or late.

(4) The danger of fall frosts.

(5) The proportion of seed that will grow.

(6) The number of seeds in a bushel.

(7) The condition of the seed bed.

Relatively larger quantities should be used (1) on heavy soils, (2) on fields such as the fallow which contains a good store of moisture, (3) in all areas subject to early fall frosts, (4) when the seeds are above the normal size and, therefore, relatively few per bushel, and (5) when the seed bed is not in good condition. If the percentage germination is low, heavier seeding should be practised.

Smaller quantities may be used (1) in dry areas, (2) on light soils, (3) on stubble fields which contain but a limited supply of water, (4) where there is no danger of fall frosts, (5) when the seeds are small in size but normally developed, and (6) when the seed bed is in good

condition. A field having a thin stand of plants will withstand the most drought; but one having a thick stand will mature earlier. The amount sown does not alone determine the thickness of the stand—the condition of the seed bed with respect to temperature, moisture and tilth is of equal or greater importance in this connection. Thin seeding on a good seed bed often results in a thicker stand than thick seeding on a poorly prepared seed bed.

The amounts used in different parts of the West vary, with wheat from ¾-bushel to 3 bushels; oats, 1 to 5; barley, 1 to 3; winter rye, ½ to 1½; flax from 20 pounds to 50 pounds, and peas, 1¼ to 3½ per acre.

As little as ½-bushel of wheat and 1 bushel of oats are reported to have given good returns on light soils in southwestern Saskatchewan in a dry year, while as much as 2½ bushels of wheat and 5 bushels of oats have been used on fallowed land on the heavy rich soils of northern Alberta and Saskatchewan.

In a dry season at Saskatoon 20 pounds of flax, ½ bushel of winter rye, and ½ bushel of wheat each produced a larger yield than any thicker seeding, but in a "wet" year when the frost came early in the fall our largest yields of wheat and oats were secured when 2½ bushels and 4 bushels, respectively, were sown.

The normal amounts of seed used on medium soil types are for wheat, 1 to 1¾ bushels per acre; oats, 2½ to 3 bushels; barley, 1½ to 2¼ bushels; winter rye, ¾ to 1¼ bushels; flax, 25 to 35 pounds, and peas, 2 to 3 bushels.

The results of the "rates of seeding" trials as carried out with a press drill on a clay loam soil at Saskatoon may be briefly summarized as follows:

	Amounts commonly giving the largest yield.	Range of amounts that in different years have yielded most.
Wheat	1 to 1½ bus.	½ to 2½ bus.
Oats	2½ to 3 bus.	1 to 4 bus.
Peas	2 to 2½ bus.	2 to 3 bus.
Barley (6-rowed)	1¼ to 1¾ bus.	1 to 1¾ bus.
Rye (Winter)	¾ bus.	½ to 1½ bus.
Flax (seed)	20 to 30 lbs.	20 to 40 lbs.
Potatoes	12 to 30 bus.	
Rape	3 to 4 lbs.	
Carrots	3 to 4 lbs.	
Mangels	12 to 15 lbs.	
Swedes and turnips	3 to 4 lbs.	
Corn	15 to 30 lbs.	
Grasses	See Secs. 246 to 253 and 273.	
Clovers	See Secs. 272 to 275.	
Alfalfa	See Secs. 256 and 264.	

16. The Depth to Sow. Wheat, oats, barley, rye and peas are usually sown from 1½ to 3 inches in depth, and flax a little shallower; but the depths should vary with

1. The depth at which firm, moist soil is found.
2. The kind of soil.
3. The time of seeding.

The place in the soil where optimum amounts of heat, air and moisture can be obtained is generally the best depth to sow. In this country, moisture is the most important of these factors and, therefore, generally controls the depth at which seeds should be placed.

Very often the soil is not properly prepared and as a result the surface is dry to a considerable depth. Under these conditions the best depth to sow cannot be foretold. In loose soils the seed should be sown deeper than on firm soils. On fall or spring plowed land it should be sown deeper than on fallowed land, and on light land deeper than on heavy land. Early seeding should generally not be done as deeply as late seeding. On stubble

fields a common fault is too shallow seeding. With the cereals to "sow into the moisture" is a good motto if the soil has been managed in such a way as to have the mois-

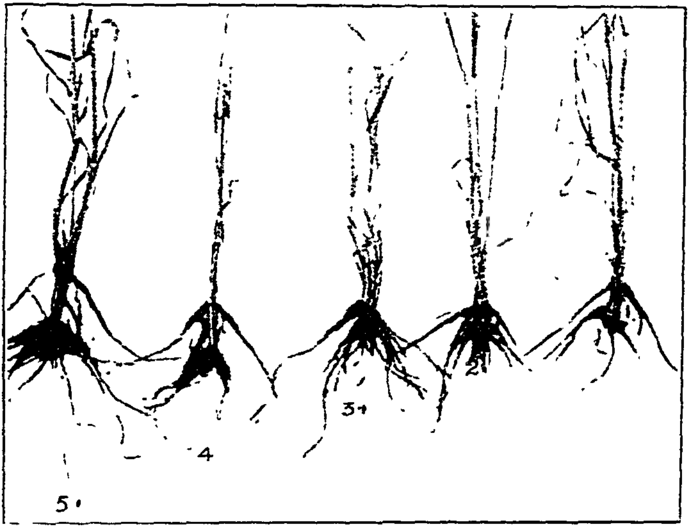

Fig. 7.—Wheat Sown at Different Depths.
Root development of wheat plants from seeds sown at depths varying from 1 inch (on the right) to 5 inches (on the left). The permanent roots develop at the same point in the soil regardless of what depth the seed is planted. The figures show the location of the seed in each case.

ture within one to three inches from the surface. For crops having smaller seeds, the land should be so prepared as to have the moisture nearer the surface, in order that the necessary conditions for germination may be secured without having to sow too deeply. In dry climates poor stands of grain result from shallow seeding more often than from deep seeding.

17. What is Good Seed? Having noted something of the nature of seeds and the functions of their different parts we should now answer for ourselves the question

"What is Good Seed?" Our judgment of the seed is largely determined by its germinating qualities and its purity. In other words, when bulk grain is judged for seed its value must be estimated not alone by the intrinsic value of the individual seeds which make up the bulk of the sample, but also by its freedom from noxious weeds and other impurities.

Good seed, then, is—

(1) Seed that will grow.
(2) Seed that will grow vigorously.
(3) Seed that is from a suitable variety.
(4) Seed that is from a well-bred strain of a suitable variety.
(5) Seed that is free from weeds.
(6) Seed that is free from disease.
(7) Seed that is pure as to class.
(8) Seed that is pure as to variety.

The first four requirements relate to the seed itself, the last four to its purity. Items Nos. 1, 2, 3, 5 and 6 are probably the most important. In the score card (Sec. 19) Nos. 1 and 2 are considered under "vitality," No. 3 under "suitability of variety," Nos. 5 and 6 under "purity," and Nos. 4, 7 and 8 under "trueness to type."

It cannot be disputed that seed that will meet the above requirements will always be good seed. The difficulty is in being able to tell on examining a sample whether it will meet these requirements or not.

18. Judging Seed.—To enable one to get at the value of a sample of grain for seed it is important that there be available information concerning—

(1) The suitability of the variety to the district.
(2) The percentage and vigor of germination of the seed, and

(3) The impurities, such as weeds, disease, other classes of seeds, other varieties and useless matter present.

This information is always procurable for grain that has been examined in the field, tested for germination and purity in the laboratory and then judged as seed.

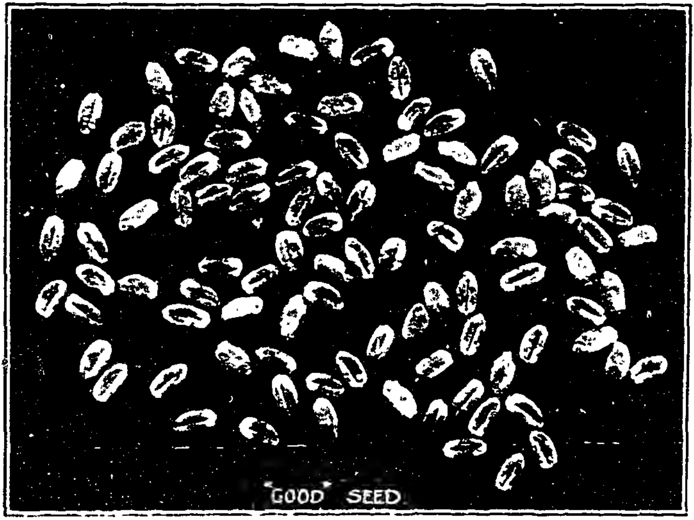

Fig. 8.—World's Champion Wheat Seed.
The seed that won the championship at the International Soil Products Exposition at Denver in 1915. Grown by Seager Wheeler of Rosthern, Saskatchewan.

But often purchasers, as well as judges, have only the threshed sample on which to base their judgment. To aid the farmer in purchasing and the judge in making his award as seed fairs "score cards" based on the requirements of "good seed" have been prepared. Typical score cards (in composite form) for seed and "fields for seed" of wheat, oats, barley, rye, flax, peas, grasses and clovers and alfalfa are given below:

19. Score Card for Seed.—

	Wheat	Oats	Barley	Rye	Flax	Peas	Grasses	Clovers & Alfalfa
Suitability of variety	8	8	8	8	8	8	.	10
Vitality								
(a) Soundness	18	18	18	20	15	20	15	20
(b) Plumpness	12	12	12	14	12	15	20	20
(c) Lustre	5	5	5	5	5	5	10	10
Purity								
(a) Weed seeds	25	30	25	20	30	18	30	25
(b) Other kinds of seeds	8	8	8	8	5	5	10	5
(c) Disease	10	5	10	15	15	10	5	5
(d) Broken grains, chaff, dirt, etc.	5	5	5	5	5	10	10	5
Trueness to type								
(a) Species	5	5	5	5	5	5	..	.
(b) Variety	4	4	4	..	..	4	..	
Total	100	100	100	100	100	100	100	100
Deduction for serious faults								
Net total								

20. Score Card for Standing Fields for Seed.—

Perfect Score

		Wheat	Oats	Barley	Rye	Flax	Peas	Grasses	Clovers & Alfalfa
1	Suitability of variety	10	5	10	5	5	10	..	20
2	Freedom from weeds	25	30	25	30	30	20	30	20
3	Freedom from other kinds of cultivated plants	15	15	15	15	10	15	20	10
4	Freedom from other species and varieties	10	10	15	5	10	10		
5	Freedom from disease and insect injury	15	15	15	20	20	15	10	
6	Apparent yield	15	15	15	20	15	15	30	30
7	Earliness	10	10	5	5	10	15		10
8	Uniformity of maturity				.		..	10	10
	Total	100	100	100	100	100	100	100	100
	Deduction for serious faults								
	Net total								

21. How to Secure Good Seed.—When a man is starting to farm or when he is about to start with another variety of seed, he should—

1st. Satisfy himself from his own or his neighbor's experience or from the reports of his nearest Experiment Station as to the most promising sort to grow.

2nd. Be reasonably sure that the seed he purchases is free from weeds, disease and other classes and varieties, and

3rd. Be sure that it will grow.

The best place to get a bulk supply of seed to start with is from a good farmer in ones own community. At the same time it is a good practice to secure from a member of the Canadian Seed Growers' Association or some prominent seed grower or the nearest Experiment Station or from some reliable seedsman, a small quantity of carefully selected seed, to be sown under favorable conditions and increased for future use.

The best method of securing from year to year seed that will possess all the qualities desired is to grow one's own supply. If properly attended to, this involves some extra care with that portion of the crop that is selected to produce seed for the next season. The land should be in a good state of cultivation, reasonably free from weeds and also from diseases that live over in the soil. Seed sown on this plot should be carefully treated for disease. Troublesome weeds that appear in the growing crop, as well as mixtures of other varieties, and diseased plants, should be gotten rid of by removing them by hand. "Rogueing" is one of the very best practices for preserving the purity of any variety. If the seed has been injured by frost, rust, heating or other causes, its

value for sowing may be improved by grading with a fanning mill, although heated grain for seed purposes should, as a rule, be avoided.

Any farmer who so desires may attempt the improvement of his crops by selection (See Secs. 93 to 96). The breeding of wheat is primarily the work of the Experiment Station and need not be undertaken by the farmer. He may, however, perform a valuable service both to himself and to the community by preserving his seed in a state of purity and passing it on to others who are anxious to get a start in pure seed.

No one should allow the impulse to grow new and much-heralded varieties to get the better of his judgment. Improved strains and varieties will appear from time to time, but many unsuitable ones are sure to be offered. Until comparable data respecting the new and the old are available the farmer might well be "not the first by whom the new is tried, nor yet the last to cast the old aside."

CHAPTER II

THE CHOICE OF CROPS

The best crops to grow are the ones that return either directly or indirectly the greatest profit; and profit is measured by the difference between the cost of production and the value or selling price.

The cost of production is determined by the average yield and the average annual overhead and maintenance charges for the land, labor, and equipment necessary to grow and market the crop. The yield is fixed within narrow limits by the suitability of the crop to the climatic and soil conditions, while the cost of the land, labor and equipment is determined by existing economic conditions.

The price received is the result of such factors as the relation of the supply to the demand, the distance from market, the marketing facilities, the system of farming followed, political regulations affecting markets, the quality of the product and whether it is marketed directly as grain or hay, or indirectly as live stock, milk, butter or eggs.

At the present time in Western Canada the chief factors affecting the choice of crops in the order of their seeming importance are, (1) the climatic conditions, (2) the cost of land, labor, capital and equipment, (3) the distance from market, (4) the marketing facilities, (5) the available markets, (6) the system of farming,

(7) the soil conditions, (8) the quality of the product, and (9) the effect on the soil.

22. Crops that Suit the Climate.—The short growing season forces us to grow, among grain crops, only those

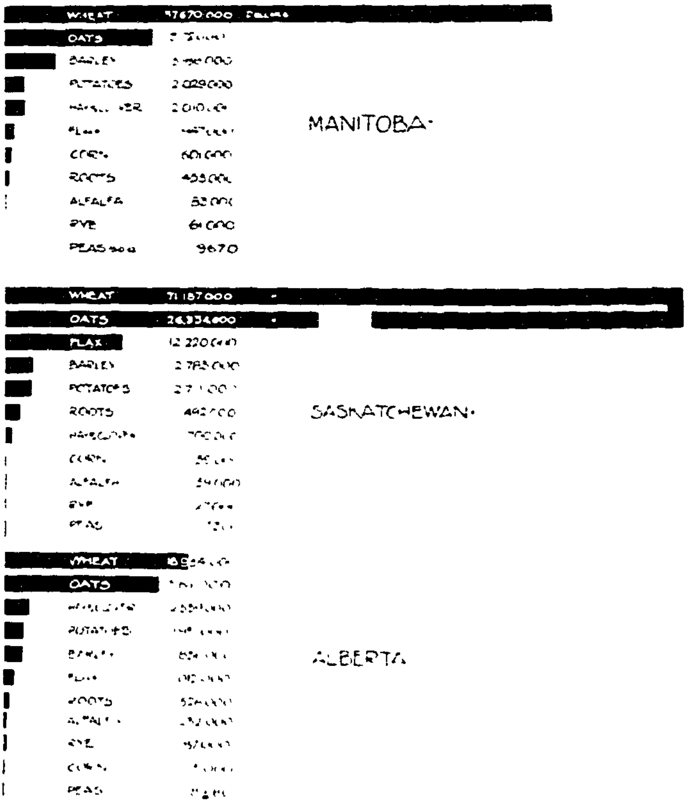

Fig 9 Relative Importance of Field Crops.

Chart showing the relative value of the principal farm crops in each of the three Prairie Provinces during the six years 1910 to 1915 inclusive.

that are quick growing, early maturing, or hardy, such as wheat, oats, barley, rye, flax and peas.

The low temperatures of winter prevent the growing of any but the very hardiest of biennial and perennial crops, such as winter rye, sweet clover, Grimm alfalfa, and hardy grasses, such as western rye grass, brome grass, timothy, Kentucky blue, red top and meadow fescue. In a few favored localities winter wheat and the common clovers may be grown with fair success.

The low precipitation in parts of the prairies, and the peculiar monthly distribution of it, favor the growth of annual or biennial in preference to perennial crops for forage, except, (1) on irrigated land where alfalfa and timothy have proven exceptionally profitable; (2) in the more humid sections immediately east of the foothills where timothy has also done well, and (3) on the light, sandy land and other abnormal types of soil where crop growing has not proven profitable, but where ranching may be carried on satisfactorily. In the drier parts wheat, rye and flax are preferred to oats and barley, while in the northern regions oats and barley are preferred to wheat or flax.

23. Crops Suited to Extensive Cultivation.—The high cost of labor, the high interest rates, the high price of machinery, lumber, and much of the other equipment necessary for farming, all foster the development of a system of agriculture, based on the extensive utilization of the only one of the means of production that is cheap, *viz.*, the land. The crop that can be grown with the least labor, the smallest investment and the least equipment is automatically though unintentionally favored. Thus the growing of forage which necessitates the purchase of live stock to consume it, the building of fences and

the erection of buildings to control and protect the stock, and generally more labor to get the necessary work done, is discouraged. All this investment costs money, and money is expensive. When labor, equipment and capital become cheaper, and land becomes more expensive, the tendency will be the other way, a much larger acreage of forage crops will be produced, and a more permanent system will result.

24. Crops that can be Marketed Cheaply.—In a thinly populated agricultural region the home market requires only a very small proportion of the total production, consequently outside markets are necessary. The world markets for the crops we grow are far removed, thus reducing the price by the amount of the transportation charges, and at the same time favoring (1) non-perishable over perishable products, (2) condensed or finished products, like live stock, butter and eggs, over bulky, less valuable shipments like grain or hay, (3) favoring also the grain crops which can be easily cured and preserved by drying, over crops like potatoes and other vegetables, and (4) favoring less bulky shipments, such as flax and wheat over the more bulky and less valuable shipments of coarse grains.

25. Crops that can be Marketed Advantageously.—The facilities for marketing constitute an important point in the choice of crops. Wheat in Winnipeg, 500 miles away, is worth only the transportation and loading charges, 6 or 7 cents per bushel, more than it is in Saskatchewan, while potatoes, eggs and butter are frequently sold in our cities for twice as much as they can be purchased for at country points 50 miles away. In the former case the marketing faciltics are efficient, in the latter they are very inefficient. At the present time

the arrangments for marketing grain are much better organized than those for any other class of farm products.

26. Crops for which there is a World Demand.—We are dependent upon consumers outside our own borders for markets for our surplus products. The larger these markets and the more accessible they are made the greater becomes the demand for our goods, the less speculative the price offered, and the more uniform the supply obtained. Of the food crops that we grow to advantage wheat is the most in demand. We need not fear for a market for our surplus wheat. Whether that

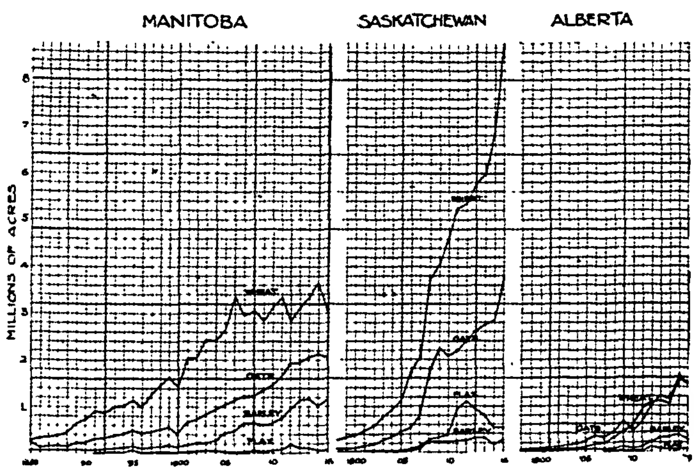

Fig. 10.—Western Canada's Increasing Grain Acreage.

Chart showing in acres the development in production of the major crops in each of the three Prairie Provinces. Constructed from data reported by the Provincial Departments of Agriculture.

market will always pay enough to make a good profit is another question. Oats and barley are exported to some extent, but the price of these is generally satisfactory

only in proportion as farmers use them to feed to stock. Flax is grown almost entirely for export, and the world requirements are not high. Flax prices, therefore, are likely to fluctuate considerably unless a uniform annual acreage is sown. The market for rye and peas is likewise very limited. The acreage that may be devoted to these and to the other crops of minor importance will probably depend upon the extent to which each can be profitably utilized as a forage or concentrate for stock, although both rye and peas and potatoes as well may find an outside market.

27. Crops that Suit Different Systems of Farming.—If a man prefers a certain system of farming he should first eliminate such crops as are not suited to the climatic soil and economic conditions in which he finds himself, and from those remaining select the ones that best fit his system of farming. The dairy farmer, the mixed farmer and the grain farmer each need different crops in different proportions. The dairy farmer needs more pasture and hay crops and succulent winter feed than the mixed farmer, while the latter needs more forage crops than the grain grower, and perhaps different ones.

The best grain crops may be any of wheat, oats, barley or rye (or flax), depending upon the soil and climatic conditions; the best hay crops, western rye grass, timothy, brome grass, alfalfa, millet or oats; the best pasture crops, brome grass, western rye and Kentucky blue, alfalfa, mixed grains, or even rape; the best silage crops, corn, oats, or oats and peas, or sunflowers; and the best succulent winter feed may be silage, or root crops such as swede turnips or mangels.

28. Crops that Suit Different Soils.—Heavy soils are usually rich, but cold. Light soils are generally less fer-

tile, but warm. Medium types, such as our loams, are intermediate in both fertility and warmth. Where fall frosts are feared, warm soils are preferred. Where drought occurs frequently the medium and perhaps the heavier types are best. Wheat will grow on any normal soil, but in dry areas prefers the medium and heavy types. In the more northerly parts wheat does best on the medium and lighter types. In general it may be said that the warm soils are best suited to truck crops and corn, the medium types to the grain crops, and the heavier types to flax, coarse grains, cereals for forage, and root crops. Among the cereals rye is the best suited to lighter soils, and oats to heavier soils.

29. Crops of High Quality.—The price of all crops varies with the grade, and the grade is based upon the evidence of food value, of which inherent quality is one.

In western grades of market wheat "quality" means high gluten content, and this is evidenced by a hard, dense, glutinous kernel. Wheat of this character grades higher and sells for a better price than softer, less glutinous wheats. Among the varieties of good quality are Marquis, Red Fife, White Fife, Pioneer and Prelude.

In market oats "quality" means a low percentage of hull or a high percentage of kernel. Unfortunately only the lowest yielding varieties have the least hull. Our best varieties are from low to medium in percentage of hull. Among these are Banner, Victory, and Gold Rain. In commercial flax "quality" has reference to the oil content of the seed, a subject which has received very little study in Canada yet. In hay crops, "quality" includes composition and disgestibility, figures of which for the different forage crops may be seen in the table of composition in the Appendix.

30. Crops that Affect the Soil Favorably.—Different crops affect the land in different ways. The use of intertilled crops favors the conservation of moisture, the development of available plant food, and the control of

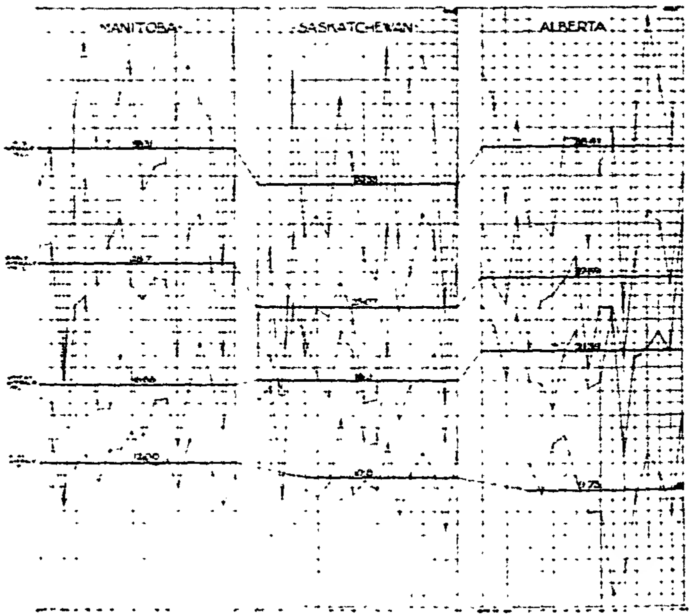

Fig. 11. Annual and Average Yields.

Chart showing annual and average yields of the major crops in each of the three Prairie Provinces. Constructed from data reported by the Provincial Departments of Agriculture.

weeds. Legume crops, like the clovers, alfalfa and peas, accumulate atmospheric nitrogen, the most valuable fertilizing constituent the soil requires. Grass crops, such as brome and western rye, add "root fibre" to the land and aid in controlling annual and biennial weeds. Grain crops—and these are our so-called cash crops—remove

plant food from the soil without leaving any of these favorable conditions.

The amount and market value of the most important plant food elements removed from the soil by different crops and some live stock products is shown in the following table from "Soil Fertility and Permanent Agriculture", by Hopkins:

Produce.		Pounds.			Market Value.			
Kind.	Amount	Nitrogen.	Phosphorus.	Potassium.	Nitrogen.	Phosphorus.	Potassium.	Total value.
Wheat, grain	50 bu.	71	12	13	$10.65	$ .36	$ .78	$11.79
Wheat, straw	2½ T.	25	4	45	3.75	.12	2.70	6.57
Oats, grain	100 bu.	66	11	16	9.90	.33	.96	11.19
Oat straw	2½ T.	31	5	52	4.65	.15	3.12	7.92
Timothy hay	3 T.	72	9	71	10.80	.27	4.26	15.33
Clover seed	4 bu.	7	2	3	1.05	.06	.18	1.29
Clover hay	4 T.	160	20	120	24.00	.60	7.20	31.80
Alfalfa hay	8 T.	400	36	192	60.00	1.08	11.52	72.60
Potatoes	300 bu.	63	13	90	9.45	.39	5.40	15.23
Sugar beets	20 T.	100	18	157	15.00	.54	9.42	24.96
Fat hogs	1000 lb.	18	3	1	2.70	.09	.06	2.85
Milk	10000 lb.	57	7	12	8.55	.21	.72	9.48
Butter	400 lb.	0.8	0.2	0.1	.12	.01	.01	.14

31. Prices Received for Farm Crops.—A critical analysis of the actual prices received in the West for the different farm crops covering a long period of years is not available. Figs. 12 and 15 indicate the average and yearly prices of the "major" and "minor" crops for a few years preceding the war, while in the Appendix may be found statements showing the average price per bushel per year for the principal grades of wheat, oats, barley and flax, the monthly Winnipeg cash price for No. 1 Northern wheat in store at Fort William, the range of prices of contract grade wheat, oats, barley, rye, flax and potatoes (at Chicago or Duluth), and the aver-

age price of wheat, barley and oats in England and Wales for the forty years preceding 1915.

32. Classes of Field Crops Commonly Grown in the West.—The field crops that experience has shown may be commercially grown in western Canada may be grouped under—

1st. Those grown for their seeds.

2nd. Those grown for their stems and leaves.

3rd. Those grown for their roots or other underground parts.

To the first class belong our common cereal crops—wheat, oats, barley and rye, and flax and peas, and such of the grasses, clovers and alfalfa as may be grown for their seed.

To the second class belong such of the grain crops as may be cut green for hay, the millets, clovers, grasses, alfalfa, corn and fiber flax.

To the third class belong the root crops—swedes, turnips, mangels, sugar beets and carrots,—and potatoes.

33. The Relative Suitability of the Different Cereal Crops.—The grain crops are better suited to the conditions now existing on the prairie areas of western Canada than any other crops. They (1) resist frost in the spring, (2) mature relatively early in the fall, (3) have th[illegible] growth in our "warm" and "wet" season—M[illegible] July, and August, (4) being annuals, they per[illegible]se of the fallow for storing moisture, (5) bei[illegible] to extensive cultivation, they lend themselves well to the land and labor conditions now existing, and (6) when grown they find well-developed marketing facilities and generally a good market.

In so far as production is concerned the chief difference in the requirements of these crops is to be found

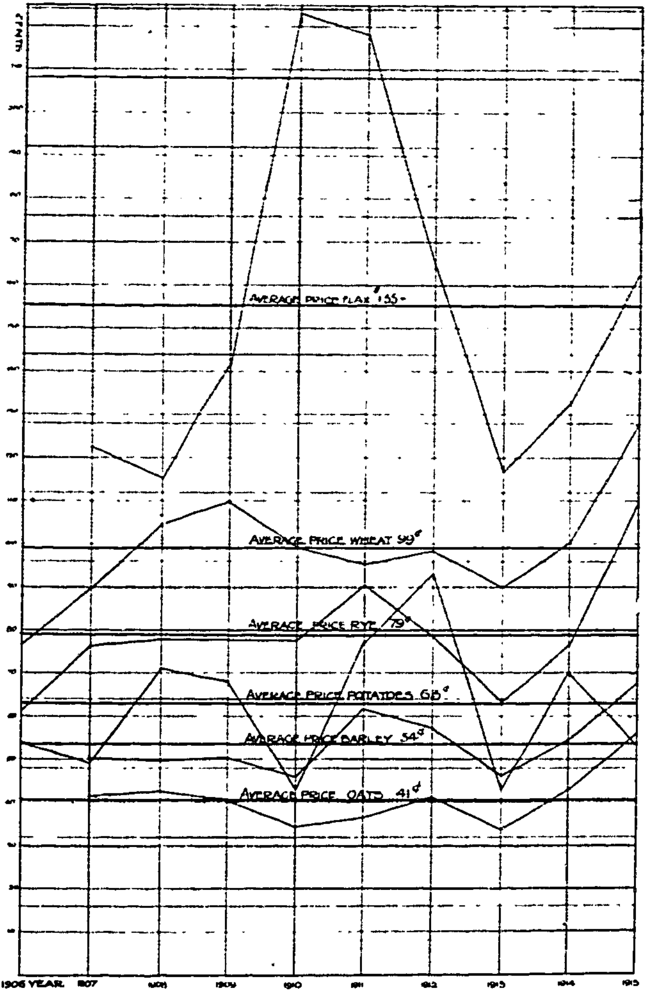

Fig. 12.—How Grain Prices Fluctuate.

Chart showing annual and average prices of the major crops of Western Canada. The figures for wheat, oats, barley and flax are the Winnipeg cash prices, while those for rye and potatoes are Chicago prices

in the time required to mature them. Wheat requires longer than oats, and oats longer than barley or rye. Rye and wheat are rather more resistant to spring frosts than oats, and oats more than barley. It is generally believed that wheat requires a better seed bed and earlier seeding than the other cereals. Rye will do better than the others on lighter and poorer soils. Oats like the cooler, more moist regions. Barley prefers similar conditions to oats. Wheat does best on the medium soil types in the prairie areas that have a fair length of growing season.

34. Wheat Varieties.—The characteristics most desired in western Canadian wheats are high quality and high yield. In addition to these, early maturity, non-shattering propensity, strong straw and disease resistance are characteristics to be desired. The best winter varieties are Turkey Red and Kharkov. The best spring varieties are Red Fife and Marquis. Among the very early varieties are Pioneer, Reb Bobs, Ruby and Prelude. The best macaroni varieties are Kubanka and Pelissier. (See Secs. 83 to 90).

35. Oat Varieties.—The qualities most desired in oats are high yield, high quality, strong straw, earliness and disease resistance. Banner, Victory and Gold Rain are the best late white oats, Ligowo the best medium early oat, and Daubeney one of the best early oats. (Secs. 138 and 139).

36. Barley Varieties.—The barley crop in the West is grown mostly in the early fall frost areas, and on the older and more weedy land. The chief faults of the crop are its weak straw when grown on rich soil, a tendency of the heads to break off and the seeds to shatter, and the presence of beards.

The six-row bearded hulled type has generally been recommended for all parts of all three provinces, Manchurian and O. A. C. No. 21 being the popular sorts. It now seems probable that Hannchen, a two-row variety, is likely to prove more productive in the drier parts of Saskatchewan and Alberta. Canadian Thorpe, a large seeded two-row barley, is also becoming quite popular in this area. The best early barleys are Early Six and Albert. The hulless barleys are not so productive as those mentioned above and are very little grown. (Secs. 166 and 167).

37. Rye Varieties.—Spring rye as a cereal crop is very little grown. It is an early maturing crop and one well suited to the lighter and poorer types of soil and to the drier parts. It does well on heavier, more fertile soil, but on these is not so productive of grain as wheat, oats or barley. It is sometimes grown as a hay crop. It furnishes good pasturage, but the quality of hay for general use is inferior to that of oats or barley. The most productive varieties are Prolific and Ottawa Select.

Winter rye promises much more in the west than spring rye. Northern grown winter varieties have proven quite hardy at most places where they have been tried. Eastern and southern grown sorts are too tender for our winters. In areas subject to soil drifting or where wild oats are prevalent this crop should be found useful either for early pasturage for cattle, sheep or hogs, for hay, or even for the threshed grain. North Dakota No. 959 and Saskatchewan rye are the hardiest varieties. (See Secs. 185, 186 and 191).

38. Flax Varieties.—This crop finds its best environment on newly-broken heavy soils. The brown-seeded, blue-blossomed type has been found better suited than

any other to our soil and climatic conditions. The golden-seeded type is later, shorter in the straw and poorer in yield than the brown-seeded type. No white flowering

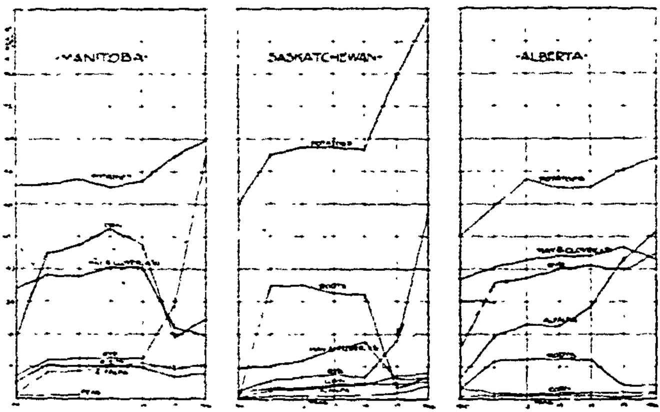

Fig 13.—Production of Minor Farm Crops.

Chart showing (in thousands of acres) the development of production of the minor farm crops in each of the three Prairie Provinces. Constructed from data reported by the Provincial Departments of Agriculture.

sorts have yet produced as satisfactory yields as the blue-blossomed ones. Premost is at present the standard variety. Other strains produced by the North Dakota Experiment Station and said to be resistant to flax wilt are North Dakota No. 155, North Dakota No. 52, North Dakota No. 73, and North Dakota No. 114. It is not claimed that the last four varieties are heavy producers on undiseased soil. They have, however, demonstrated their usefulness on the flax sick soil of North Dakota. (Sec. 201).

39. Field Pea Varieties.—The field pea is but little grown in the west, because of (1) danger of frost in the fall, (2) low yields in the drier areas, (3) the difficulty

in harvesting, and (4) the relatively high cost of seed and harvesting. It is, however, our most suitable annual legume, and yields of from ten to sixty bushels per acre have been reported from different places. The varieties that are considered best for general use are medium early sorts—Arthur, Carleton and Golden Vine and the early sort known as Early White.

40. Classes and Varieties of Forage Crops.—Under semi-arid conditions long-lived or perennial crops do not yield as well as the shorter-lived annuals and biennials. This is explained by the fact that much more frequent opportunity to store moisture and develop plant food is given in the case of annuals and biennials than with a crop which lives several years. At the same time perennial crops cost less to produce, since there is no charge for soil preparation, seed or seeding after the first year.

It is our opinion that in the drier areas greater reliance must be placed on the short-lived crops than on the long-lived ones. Yet the latter are essential for such permanent or semi-permanent pastures as it may be found advisable to use. We have insufficient data to determine which is the more profitable under all conditions. It would seem, however, that we should plan, in the drier parts at least, to get the bulk of our hay from annual crops and depend upon the perennials for some early spring pasturage, some hay, and a reserve pasture for horses and other stock when the annual crops may not be ready for pasturing. Where weeds are prevalent or where soil drifting is common a larger proportion of perennials is desirable. The more humid the district the more successful perennials will be, the drier the area the more annuals must be depended upon. The proportion of each should be determined by the climatic

conditions, the system of farming followed, and the needs of the soil.

The best perennial hay crops for general use in West-

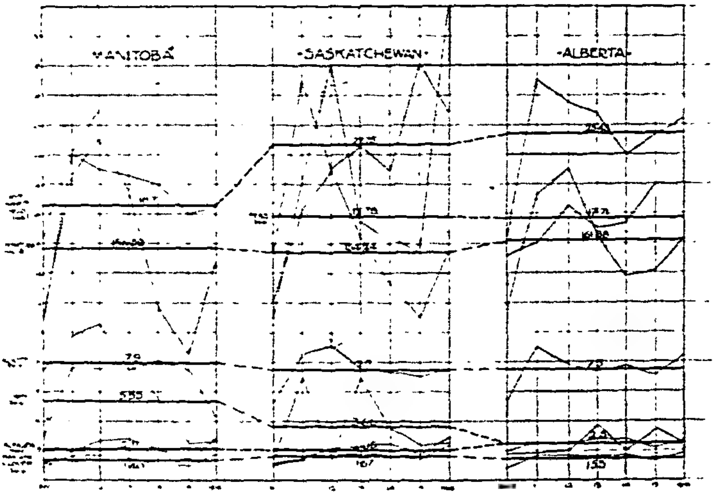

Fig 14 —Yields of Minor Farm Crops.
Chart showing annual and average yields of the minor crops of the Prairie Provinces. Constructed from data reported by the Provincial Departments of Agriculture

ern Canada are western rye grass, brome grass, timothy and alfalfa, either singly or in combination.

The best biennial hay and pasture crops are winter rye and sweet clover.

The best annual hay crops are oats, peas and oats, beardless barley and spring rye.

Crops that are of secondary importance for hay and pasture are Kentucky blue grass, red top, meadow fescue, and the millets. Some that may later become useful are the clovers, red and alsike, and sweet clover, the last mentioned promising most for the open plains.

The best crops for permanent pasture are brome grass, or brome grass and alfalfa mixed. Less productive though useful pasture mixtures are Kentucky blue grass, or red top, mixed with either timothy and alfalfa or western rye and alfalfa.

The best crops for annual pasture are oats, or peas and oats, or barley and oats, and rape.

Sweet clover, a biennial, may become a useful pasture plant, particularly on light soils in what are now regarded as purely grain-growing areas. Winter rye also furnishes good pasturage in late fall and early spring.

41. Silage Crops, Soiling Crops and Fodder Crops.—Where much live stock is kept, particularly milking cows, a succulent winter feed is very desirable. By some it is considered essential to successful winter dairying. Corn is the great silage crop of eastern and southern dairy districts. It can be grown here quite satisfactorily in many parts, but owing to its immaturity the quality of the silage made from it is frequently low and the cost of production is relatively high. The best ensilage crops are corn for the South, and oats, or oats and peas, for the North.

Oats and peas, particularly in the North, seem now to promise cheaper and better silage than corn. Very excellent results have been secured at the Lacombe Experimental Farm from both oats and mixed peas and oats as silage. Neither of these has, however, been used extensively as silage crops as yet. The utilization of sunflowers by ensiling is now being tested at different places with considerable success. Mixtures of alfalfa or sweet clover with winter rye in seasons when the legume crop cannot be satisfactorily cured also has some possibilities.

The best soiling crops, in the order of their possible

readiness for use, are winter rye, alfalfa, peas and oats, corn, and rape. The chief fodder crops are oat straw and corn stalks. Some good but less common fodders are the straw of threshed alfalfa, clover, brome grass and peas. Minor fodders are the straw of barley, wheat, rye, flax, and western rye grass.

42. Green Manure Crops.—Green manuring is seldom intentionally practised. The plowing under of weeds in the fallow year, and of cultivated crops after being hailed out, increases the organic matter content of the soil, even though not done for that purpose. If the practice of plowing under cultivated crops develops it is probable that sweet clover will be found the best for this purpose, particularly in the prairie area. If a strain can be found sufficiently hardy to live through the winter, after being sown with the last grain crop in the rotation, it may be plowed under early in the fallow year without the loss of the field for a longer time than is now lost by fallowing. This practice is likely to develop rapidly on soils that blow and on those that are low in organic matter, although in dry areas very early plowing will be necessary if sufficient moisture is to be conserved.

43. Varieties of Root Crops.—The so-called "root crops" —swedes, turnips, mangels, sugar mangels, sugar beets and carrots—furnish "succulence" to the winter rations of live stock. They have a regulative and medicinal value, and they also increase the digestibility as well as the amount of the coarse, dry fodders consumed. Root crops in the drier parts cost more to produce per pound of dry matter than any of our other crops. Whether it will pay to grow them depends upon the yield and the need for succulent food. Where much stock is kept, particularly dairy animals, the need for silage or roots is

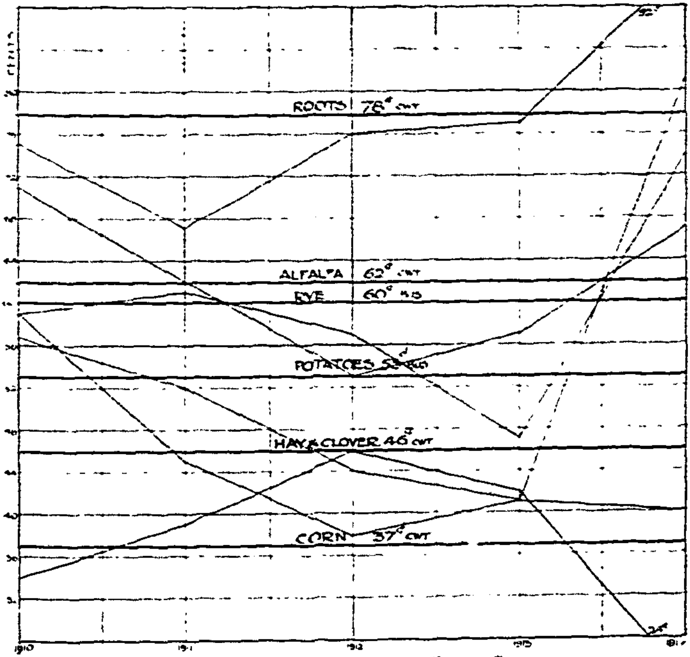

Fig. 15.—Prices of Minor Farm Crops.
Chart showing annual and average local market prices for each of the minor crops in the Prairie Provinces. From data reported in the Canada Year Book.

great. The "globe" type of swedes, the "intermediate" mangels, and "intermediate" carrots are generally preferred. (Secs. 310 to 317).

44. Varieties of Potatoes.—Several qualities combine to determine the suitability of different sorts for western conditions. Among these, yield, cooking quality, disease resistance, early maturity, shape and depth of eyes, are among the most important. Many scores of potato varieties have been tested in Western Canada, and the same ones have not proven best under all conditions. The

varieties recommended by the different Experimental Farms and Stations are indicated in the chapter on Potatoes. (Secs. 334 and 335).

45. Varieties of Corn.—The corn crop offers the grower a very wide field of choice. The early maturing types are all short, the late maturing ones tall, and there are many intermediate forms.

The "Squaw" group of varieties is the earliest and shortest, Free Press or Patterson a little later and somewhat taller, Gehu and Quebec No. 28 later still, but more productive of both grain and forage, while North Dakota White, North Western Dent and Longfellow, in this order, are later in maturing, more productive of forage, and the kinds most commonly grown.

CHAPTER III

THE PRINCIPLES UNDERLYING PLANT GROWTH

A knowledge of the principles underlying the growth of crops is essential to an intelligent understanding of the causes of low yields and the means by which man may prevent or control them. If these principles are not appreciated by the man who directs the management of land, his farming practices are good only in proportion as he may have been fortunate in having successful neighbors or forerunners to imitate, or in so far as accident or observation has shown him the value of specific methods. To grow crops by imitating the successful methods of others is generally good practice, but to be able to appreciate the deficiencies of the soil and climatic conditions found, and to provide the most profitable means of supplying these deficiencies, raises farming from its early status as a menial occupation and more or less pure gamble, to that of a science and an art, in which man may to a considerable extent direct the forces of nature to desired ends and make of himself a rational constructive force and not merely a "hewer of wood and a drawer of water". In this chapter the chief principles of plant growth that are of concern to the crop grower are briefly discussed.

46. Reproduction.—The primary function of plant and animal life is reproduction. Plants commence life in

several different ways. The potato plant may be grown from potato seed or from a piece of the enlarged underground stem known as the tuber or potato. The willow or the geranium may be grown from seed or from the end of a new branch, known as a cutting. Strawberries and white Dutch clover may reproduce by above-ground stems which have the power to take root at the joints after being in contact with the soil. Brome grass reproduces in a similar way, but from underground stems, which have the power of sending up branches from their joints. Timothy grows from seeds or from bulbs formed at the base of old plants. New growth on trees may be started by grafting or budding. The rust and smut plants reproduce by means of spores. Our common cereal plants reproduce only by means of seeds.

47. The First Stage in the Growth of Seed Plants.—The first stage in the growth of plants that start from seed is germination. This was discussed in the second chapter. For germination to take place there must be suitable moisture, temperature and air conditions provided, and the seed must be alive. Given these four things, a seed will germinate.

48. The Second Stage.—The time between germination, or the sprouting of the seed, and the appearance of the green leaf above ground may be considered the second stage of growth. During this period suitable conditions of soil moisture, soil temperature and soil air are necessary, and in addition there must be a supply of plant food material for the young seedling. The only source of the latter is the store of nourishment in the seed itself. This is spoken of in wheat as the "endosperm". Until the green leaf is formed above ground the seedling is wholly dependent upon this supply. The little roots

that appear at this stage may take in moisture, carrying chemical substances in solution, but these elements are of no value in nourishing the plant until they are built up into organic compounds such as sugar and protein, and this building up or synthesis can only occur in the green leaf. It is, therefore, apparent that the vigor of growth at this stage, as well as the recovery of the seedling after unfavorable conditions, such as backward weather, frosts or drifting soil, is largely dependent upon the size and quality of the seed planted.

49. The Third Stage of Growth.—At the beginning of this stage of growth the primary or seminal roots have already developed, one or more green leaves have shown themselves above ground, the nutritive material in the seed has been partially or completely used up and the little plant is practically, if not entirely, dependent upon its environment for its future development. If the soil and atmospheric conditions are favorable, satisfactory growth continues. In so far as either becomes unfavorable the growth is retarded. The plant food can no longer be secured from the seed, but must come from the leaf, where it is manufactured from substances secured from the soil, the air and water. These elements can be manufactured by the leaf into a form suitable for nourishing the plant only in the presence of light and under a favorable temperature. Hence it is that there are five factors essential to growth in this stage, *viz.*, moisture, heat, air, light and certain chemical substances.

These chemical substances are frequently spoken of as "plant food". This is only partly correct. They are plant food materials, but cannot nourish the plant until made suitable for this purpose in the leaf. The products made from them by the leaf do nourish the plant tissues

and are properly spoken of as plant foods. Among these are sugar, starch, protein and oil.

50. Why Water, Heat, Air, Light and Chemical Substances are Necessary for Growth. From 75 to 90 per cent. of the weight of green plants is water. This substance performs several distinct and important functions in the growth of the plant. The first is to carry the plant food materials in solution from the soil through the roots and stems to the leaves; the second to transfer the food manufactured in the leaves to different parts of the plant, either for storage or for nourishing the tissues; a third function is to regulate the temperature of the plant; a fourth is to prevent it from wilting; and in addition water supplies two essential elements of plant food—hydrogen and oxygen. The temperature is controlled by the evaporation of moisture from the leaves, and wilting is prevented by the turgidity of the cells due to distention with water. None of these functions can go on normally if water in sufficient quantity is not available.

A certain amount of heat is necessary before the life processes can go on. Osmosis does not proceed and soil bacteria do not perform their functions at low temperatures. Chemical action practically ceases and the movement of water solutions is entirely prevented at temperatures below freezing. Cereals will germinate at a temperature as low as 40° F., beans and corn at about 50° F., and cucumbers and melons at about 66 to 68 F. The best temperature for most crops is about 82° F., but the optimum for corn, beans and cucumbers is about 90° F. Plants will live at much higher temperatures, but stop growth when the maximum growing temperature is reached. The power to withstand both heat and cold

depends very largely upon the amount of water in the plant cells. The greener and more succulent the tissues the greater the injury, the more mature and dry the tissues the less the injury. Some tender succulent plants are killed with a very light frost, while mature seeds have been known to germinate freely after being subjected to a temperature of 450° F. below freezing.

Air is necessary for growth because it contains oxygen, which the plant requires for respiration and without which all vital functions of the plant cease. The carbon dioxide which is always present in the air is an essential plant food material. In the soil, air is necessary for the growth of plant roots as well as that of desirable bacteria.

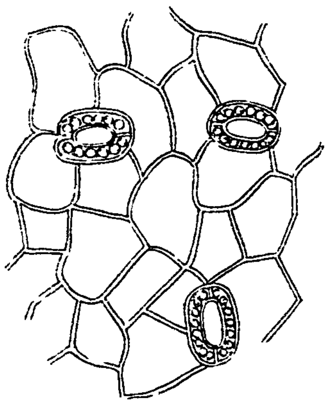
Fig. 16.—Diagram Showing Stomata on Under Side of Leaf.

Chemical elements are essential to growth because it is from these the plant tissue is built up. Ten only are esential, but twelve are frequently used and fifteen may be drawn upon. The essential elements and the source from which plants derive them are as follows: Carbon and oxygen from the air, hydrogen and oxygen from water, and nitrogen, phosphorus, potassium, magnesium, calcium, iron and sulphur from the soil. Two other elements, sodium and chlorine, are frequently found in plants, but are not essential to growth. The ones that have come to have a money value through their extensive use in fertilizers are nitrogen, phosphorus, potassium and calcium.

Light is necessary for the manufacture of the elements received from the air and the soil into a form suitable for nourishing the plant tissues. The building up into sugar of the carbon dioxide secured by the leaves from the air, and the water secured by the roots from the soil, can take place only in the presence of light. This is known as carbon fixation, or photosynthesis, a process which is essential to the nourishment and therefore to the life of plants.

51. Where the Plant gets its Supply of these Essential Things.—The plant gets its supply of moisture from the soil through the root hairs by osmosis, its supply of heat from the soil and air surrounding its roots and leaves, its supply of carbon dioxide and oxygen from the air, the other food materials from the water and soil, and the light for photosynthesis from the sun.

52. How the Plant gets Nourishment from the Air.—The plant takes in carbon dioxide from the air through minute openings in the leaves, known as the stomata. It retains the carbon and gives off a portion of the oxygen. It is very little appreciated that the air furnishes most of the substance of the dry matter found in our common crops. This is all taken in through the stomata or breathing pores, which are found chiefly on the under side of the leaves. As few as 15,000 and as many as 200,000 of these little openings per square inch of leaf surface have been observed.

53. What the Soil Must Provide.—The plant receives its moisture, all of its mineral elements of plant food and its nitrogen from the soil. In addition the soil must furnish warmth enough for growth, must contain sufficient air for plant and bacterial life, and it must provide mechanical support for the growing plant. A soil that

provides all of these requirements in sufficient quantity and at the right time will always do its part towards producing a good crop. The functions of the soil may then be briefly stated as follows:

1st. To supply nitrogen and the essential mineral elements of plant food.

2nd. To store, conserve and keep available for plants the moisture they require for growth.

3rd. To furnish an anchorage for plants, and

4th. To provide the temperature and air conditions necessary for plant growth.

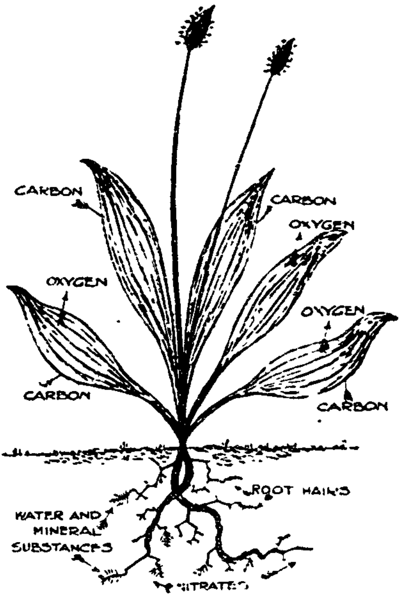

Fig. 17.—Showing How Plants Feed. The carbon is taken in from the air in the form of carbon dioxide, through openings called stomata found chiefly on the under side of the leaves. The mineral substances and nitrates in solution in water are taken from the soil through the root hairs by osmosis.—After Hunt and Burkett

The heat, air and moisture conditions of the soil are directly related to its health and tilth. These, with the presence or absence of toxic substances, weeds, insects and diseases are directly related to productiveness. To be loose enough to permit maximum root penetration and yet firm enough to lift water efficiently and to prevent rapid air movements drying out the soil; to be warm enough for optimum growth; to have sufficient

moisture for the needs of plants and yet not too much to exclude the necessary air: these are the much to be desired physical conditions in all cropped land and with the maintenance of available plant food materials, the control of toxic conditions and the prevention of weeds, insects and plant diseases, constitute the chief factors to be kept in mind in planning all soil management practices.

54. How the Plant takes in Water and Chemical Substances from the Soil.—The organs which take in water from the soil are the small rootlets and tiny root hairs usually found near the tips of growing roots. The process by which the water is taken in is known as osmosis. Osmosis has been defined as "the diffusion or passage of liquids and solutions of substances through membranes in which no visible openings are present". If a solution of water and sugar is placed in a bladder and the bladder immersed in a vessel of water, the water in the vessel will pass into the bladder and distend it. The tendency is for the liquids to become of equal density. This movement is known as osmosis, and the sugar used is spoken of as an osmotic substance.

In the cell sap of all growing plants are to be found osmotic substances which, like sugar, have the power of attracting water from the surrounding media. When the root hairs carrying these substances stretch out into a soil containing moisture the moisture is absorbed, and if the moisture carries chemical materials in solution some of the latter pass into the roots with the water. Thus it is that "plants drink their food"

Insoluble chemical elements or those that have not been dissolved in the soil water are of no use whatever to the plant. It is therefore apparent that the farmer should

give attention to those practices that result in the development of "available" plant food from the unavailable supply in the soil.

The passage of liquids into the plant takes place only when the solution within the cells of the root hairs is of

Fig. 18.—Showing Extensive Root System of Corn.

greater density than the solution of food materials in the soil. It is apparent, therefore, that if the soil solution should be more dense than the cell sap, it would be equally possible for the moisture contained in the root hairs to pass back into the soil. This sometimes happens in the case of plants growing on alkaline soils. When the cell sap is thus withdrawn the death of the plant is the natural result. Another interesting property of root hairs is their limited power of selecting the materials they require from among those found in the soil solution.

55. How the Plant Manufactures its Food.—The chemical substances or plant food materials taken into the leaf from the air and into the root hairs from the soil are not

in a form to nourish the plant tissues. They must first be manufactured in the leaf into forms suitable for this purpose. The leaf has therefore come to be spoken of as the stomach of the plant. This is only correct in so far as each of these organs prepares the food material it receives for the body it is to nourish. As a matter of fact, each has an almost exactly opposite function. The animal stomach with its digestive juices functions in breaking down or making soluble the foods taken into it, while the leaf of the plant manufactures food from the elements derived from the soil, water and air. The most striking work of the leaf in this connection is the synthesis or building up of carbohydrates from water and carbon dioxide in the presence of light. In this process the green coloring matter of the leaf, known as chlorophyll, is an essential factor without which it would be impossible for the plant to manufacture its own food.

56. The Water Requirements of Plants.—It has been pointed out that, among other things, water is needed by the plant for the hydrogen and oxygen it contains and to serve as a transporting agency for carrying the food materials from the soil into the plant, as well as for carrying the manufactured food to different parts of the plant as needed. To supply the hydrogen and oxygen needed requires very little water, but an enormous quantity is utilized in carrying the food materials from the soil into the roots and in taking the place of that transpired through the leaves. Under different conditions of climate and soil and kind of crop the amount of water required varies from less than 250 pounds to more than 1,000 pounds for every pound of dry matter formed in the plant. The large moisture requirement of growing plants emphasizes the need for moisture

and partly explains the greater productiveness of crops in the so-called "wet" years. This large amount of water is, of course, not retained by the plant, but after depositing its load of food materials the surplus is "transpired" or passed off into the atmosphere chiefly through the leaves.

57. How the Plant Utilizes the Food it Manufactures.—The food manufactured in the leaf from materials obtained from the soil, air and water is used by the plant for various purposes. Among these are (1) the building up of new tissue as in producing new leaves or branches, (2) providing a surplus to be used later, as in the fleshy roots of turnips, (3) furnishing a supply of food for the embryo of the next generation, as in the seed of wheat, and (4) providing a palatable food for animals around the seed, thus encouraging the distribution of the latter, as in the case of many vegetables and fruits.

On being manufactured in the leaf most of the food is transported by water to the growing parts of the plant or to places where it is to be stored. In the latter case it is then usually changed to a condition more or less insoluble so that it will be better preserved. The small amount of insoluble starch formed in the leaf in the daytime is acted upon by a ferment called diastase and changed into maltose sugar, which is soluble, and in which form it is moved by water at night to the points needed. In the kernel of wheat the chief constituent of the endosperm is starch, which is insoluble in water, but which is changed to sugar, a soluble substance, during germination in order that the little embryo may absorb it.

58. The Effect of the Western Climate on Plant Growth.—The climatic conditions of the West cause far more poor crops than do the soil conditions, but, unfortunately,

the factors of climate are much less amenable to man's influence than are the soil factors. This, however, is but another reason why our climate should be better under

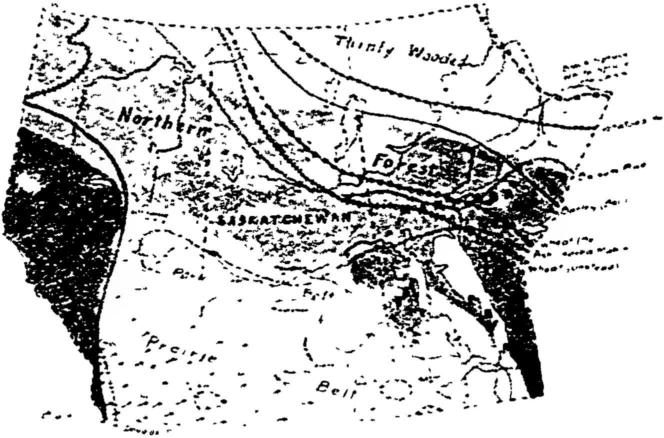

Fig. 19 A.—Nature's Map of the Prairie Provinces.

Showing wooded areas, park belt, prairie and Chinook areas, and the northern limits of several trees and crop plants. Arrows indicate the Chinook belt.

stood. If we cannot change its undesirable features, perhaps we can avoid them: if it has any favorable aspects, perhaps we can take greater advantage of them. A study of the essential facts concerning our climate should enable us gradually to choose more suitable crops and to adapt our rotation and management practices to the climatic conditions that have been fixed for us and that cannot be altered by us.

The chief climatic conditions that affect plant growth are those that influence the supply of moisture, heat and light. A brief statement of these conditions for Western Canada follows:

1. The precipitation is relatively low, ranging from $12\frac{1}{2}$ inches to 22 inches per year, as compared with over 40 inches in Ontario and nearly as much in the corn belt.

2. The driest area is in southwestern Saskatchewan and southeastern Alberta. The precipitation increases

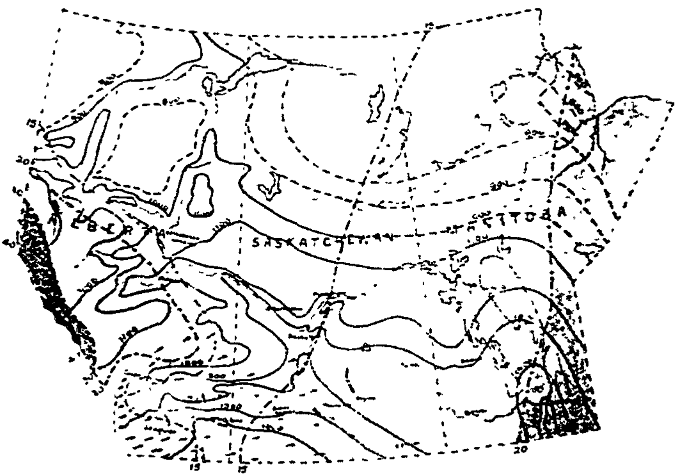

Fig. 19. B.—Precipitation and Temperature Zones.
Precipitation zones (shaded and unshaded areas) from Meteorological Service map. Temperature zones (separated by lines running generally east and west) from "The Climatic Limits of Wheat Cultivation" by Unstead in "The Geographical Journal", 1912. The figures on the heavy lines indicate the "accumulated temperatures" between the times when the mean monthly temperature curve rises above 5° C. in spring and falls to 10° C. in autumn.

considerably both east and west of this centre, but is apparently only slightly greater in the area north of it. Southwestern Saskatchewan and southeastern Alberta are the areas of greatest evaporation.

3. The monthly distribution of precipitation is particularly favorable, from 50 to 60 per cent. of the total falling in the four growing months, May, June, July and

August. The evaporation is low as compared with the southern great plains, but higher than in the humid east.

4. Approximately one-quarter of the precipitation is snow, the total annual amount increasing slightly in all directions from a line extending from Areola through Regina and Saskatoon northwesterly. A small amount falls as hail usually in July and August. It is not yet apparent that there are districts subject to hail and others not, although the premiums required for hail insurance are greatest in the vicinity of the foothills.

5. There are wide variations from the average precipi-

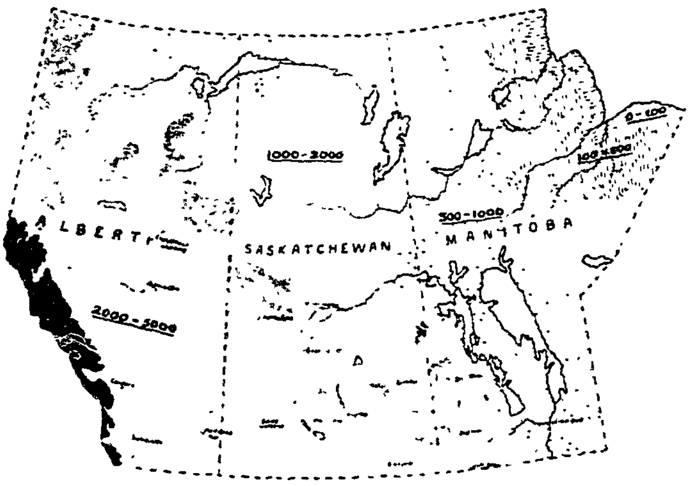

Fig. 19. C.—Altitudes of Western Canada Showing the Three Prairie Steppes.

tation, both in total amount and distribution, and these variations seem to be greatest in the Chinook belt and lesser in all directions from there.

6. The humidity of the air on the average is low.

7. The average number of days between spring and fall frosts of 3° during the years 1904 to 1915 at six different points varied between 152 and 117, the longest season being in southwestern Saskatchewan, southeastern Alberta and the Red River Valley of Manitoba. The season becomes shorter in all directions from these centres, but shortens most rapidly in the northeasterly direction and in the higher altitudes of the foothills of the Rockies.

8. The range of annual, winter, summer, monthly and daily temperatures is great. The winters are warmest in southern Alberta.

The wind velocity averages high and is highest in the open plains.

10. The number of hours sunlight during the growing season is high, and the percentage of cloudy days is low

59. The Development of the Wheat Plant.—Having touched upon some of the underlying principles of plant growth it will now be interesting to turn to the manifestations of these, as shown in the different periods of development of the wheat plant. These periods may be indicated as follows, (1) the seed, (2) germination, (3) the seedling, (4) the period of leafing, tillering and permanent rooting, (5) the period of jointing and heading, and (6) the period of flowering, fertilization, filling and ripening.

The seed is a provision of nature for reproducing the species, and consists of a miniature plant, a supply of plant food and a protective covering.

Sprouting, or the manifestation of a return from dormancy to activity, is due to the fact that the germ becomes active and starts growth as soon as the ferments in the scutellum change the starch of the endosperm into

sugar, which happens when the temperature, moisture and air conditions are right for germination. The bran bursts above the germ and the little stem and seminal roots appear.

The seedling period was mentioned in the early part of this chapter as the second stage of growth, or the stage between germination and formation of green leaves.

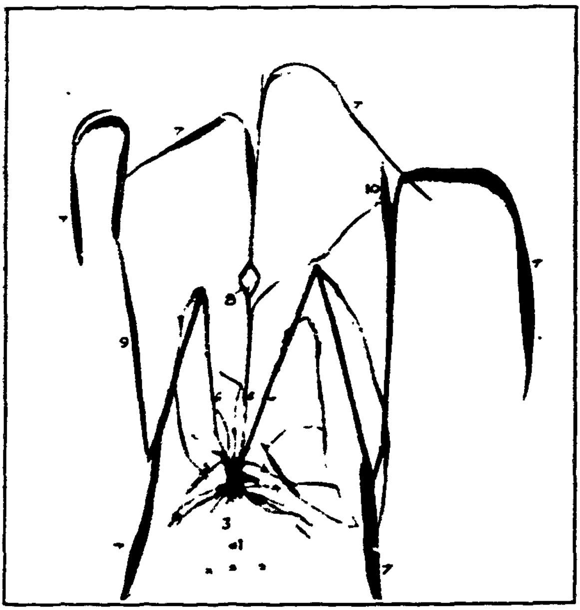

Fig. 20.—Stages in the Development of Wheat Plant. Showing (1) the seed; (2) seminal or primary roots; (3) underground stem; (4) permanent roots; (5) basal leaves; (6) culms or stems; (7) leaf blades; (8) immature head or spike within the tissues; (9) head within the "shot blade"; (10) heading out.

During this time the seedling is dependent upon its environment, which is the soil, for moisture, heat and air, and upon the endosperm of the seed for its food.

The seminal roots extend downward and outward and the stem forces itself to the surface of the soil.

During its subsequent development the plant is entirely dependent upon its environment for all the things it requires for growth. The supply of nourishment in the seed is exhausted, or nearly so, and the food must be manufactured from the inorganic constituents of the air, water and soil.

During tillering, or the early part of the plant's life above ground, the basal leaves develop and branches, or tillers, arise from the basal nodes just below the surface of the ground. The number of these depends upon how favorable the growth conditions are and how thickly the seed is sown. As few as one or as many as several dozen may develop. Under field conditions two or three tillers are commonly found. If soil and climatic conditions are satisfactory in early spring tillering progresses favorably and as a result all heads ripen at nearly the same time. If the soil is dry in spring, tillering is retarded and may take place later if heavy rains fall. When this occurs a second growth of heads may develop, thus resulting in uneven ripening, unfavorable harvesting conditions and in a lower quality of threshed grain.

During the leafing and tillering period, adventitious or permanent roots arise from the lower joints of the plant and the seminal roots die. The seed has performed its function and the plant is subsequently dependent for its nourishment upon the soil, water and air.

Heading usually occurs in this climate between the 25th of June and the middle of July. At about this time each tiller sends up from within the leaf sheath a culm, or stem, which is jointed. Just above the upper joint the tiny head may be found within the rolled leaves at a

height of only a few inches from the ground. At this stage a rapid elongation of the stem occurs and soon the wheat is in the "shot blade". In a few days the heads appear and pollination takes place, after which the anthers may be seen protruding from the glumes. The seed immediately commences to develop, passing through the early and late "milk" and soft and firm "dough" stages. In the latter part of this filling period a considerable amount of plant food stored in all parts of the stems and leaves is transported to the seed. The whole energies of the plant become centred in making as sure as possible the reproduction of the species.

Fig. 21.—Development of Wheat Plant.
Showing (1) and (2) the stage of leafing and tillering, (3) in the "shot blade"; (4) flowering and fertilization; (5) the filling stage, and (6) ripe.

The plant is said to be ripe when the movement of nutrition from the plant to the seed ceases. This is probably a short time after the plant stops drawing upon the soil and usually occurs at from four to six weeks or more after heading.

60. Dependence of Man on Plants.—Man's chief physical

needs are food, clothing and shelter, and for all three he depends mainly on plants.

The bulk of his food is taken directly from stores which plants had intended for their own use. The cereal products and potatoes, which constitute such a large proportion of his diet, as well as fruits, vegetables and sugar, are all obviously of plant origin. The balance of his food supply, consisting of meat, eggs, milk, etc., is of animal origin. But even for animal products he is indirectly indebted to plants, because all animals are dependent on plants. Those animals which do not feed directly on plants feed on other animals, which in their turn have fed upon plants. Animals and man are, in fact, directly or indirectly parasitic on plants, using either the plant body or a supply of food stored up by the plant for itself. The plant, in other words, manufactures the food supply of every living creature. (See Sec. 55).

In regard to clothing the same conditions are found. Much of the material used in making clothes—cotton, flax, fiber, straw—is taken directly from plants. The rest, including wool, hair, furs, and leather, are derived from animals, which, as we have seen, are directly or indirectly dependent upon plants.

In regard to shelter, all houses are built, in part at least, of wood, and many are built almost entirely of it. Plainly, man is indebted almost wholly to the generous beneficence of plants for his food, clothing and shelter from the weather.

In addition to these three chief needs, plants supply innumerable others. Wood enters into the construction of furniture, tools and implements of all kinds. It is changed into paper, which is used in a multitude of im-

portant ways. One need refer only to the value and influence of books, drugs, stimulants, disinfectants, dyes, many other important chemicals, as well as fibers, tobacco, etc., all of which are plant products. Finally, the remains of plants which lived millions of years ago, preserved for us as coal, petroleum, or gas, yield the heat which warms our homes and the power which drives the machinery of our industries.

CHAPTER IV

WHEAT

"The chief cereal of the open plains."

"Throughout the civilized world, wherever wheat will grow or where the people are not too poor to buy it, this grain holds the foremost place among food plants. It has always yielded 'the staff of life' to the greatest and most powerful nations since the beginning of history." It has very fittingly been called "the King of Cereals".

61. Wheat the King of Cereals.—*This grain holds the highest place among 'corn' plants, because only from wheat flour can raised white bread be made. The whiteness of wheat products has long been recognized as their characteristic attraction. Indeed, 'wheat' and 'white' come from the same word in the ancient Anglo-Saxon language. It still remains true with us that white bread is always wheat bread.

"The 'raising' of bread . . . depends upon the presence of gluten. As raised bread is most commonly made the flour is mixed with a little water and yeast to form a stiff dough, which then is vigorously kneaded so that the yeast may be well distributed throughout the mass. This accomplished, the dough is put in a warm place to 'rise'. The conditions are now favorable for the yeast

* From "Corn Plants", by Sargent, through courtesy of Houghton, Mifflin & Co.

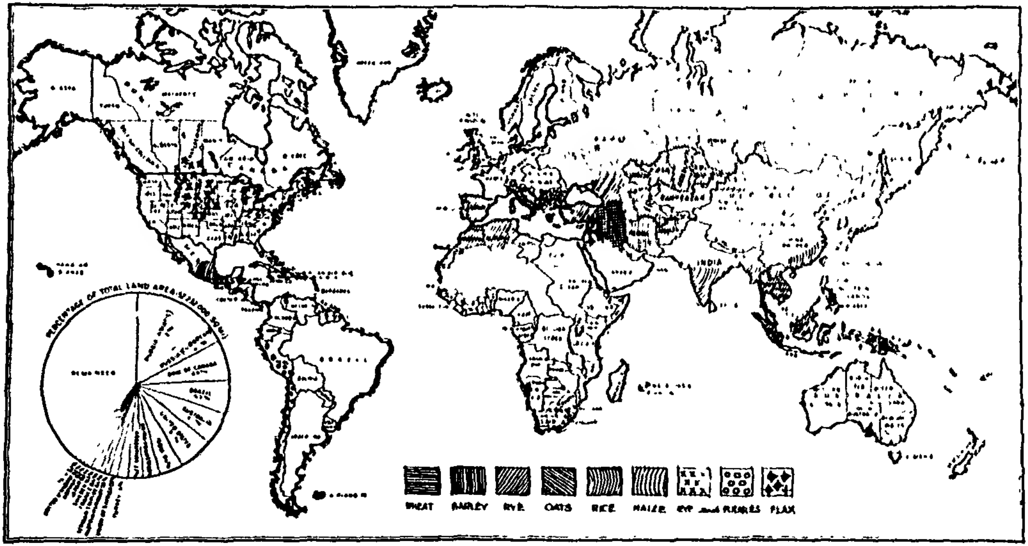

Fig. 22.—Map Showing Places of Probable Earliest Cultivation of Principal Crops.

The circle in the corner indicates graphically the percentage which the various countries constitute of the total land area of the world. Base map from the United States Department of Agriculture.

to begin its work." The chief agent in the process that goes on is an organic ferment contained in the yeast plant. This ferment "has the power to make from starch, alcohol and an odorless gas known as carbon dioxide. Each particle of yeast, made warm and moist and surrounded by starch, becomes thus a tiny gas factory. If there is nothing to prevent, the gas would, of course, escape. But in the wheat dough the gas is held in the cavities by the gluten. As the gluten is elastic, these cavities become larger and larger with the pressure of the gas within. It is this enlargement of innumerable small cavities throughout the dough which makes it 'rise' into a light, spongy mass ready for baking.

"The heat of the oven stops further action of the yeast, enlarges somewhat the cavities in the dough by expanding the gas, hardens the gluten so that the cavities cannot shrink, and then drives off the greater part of the moisture, alcohol and carbon dioxide. At last the crust comes to a perfect brown, indicating that the best flavor of the wheat has been developed. The final result is a loaf of wheat bread the highest type of human food.

"The peculiarities of wheat gluten also make possible such valuable foods as macaroni (which owes its character very largely to this substance). The same is true in general also of crackers or biscuits, especially the tough, long-keeping sort known as ship biscuit, or hardtack, which forms the chief vegetable food of crews at sea. In general it may be said that the innumerable articles of human food which consist wholly or in part of wheat owe their special excellence to the peculiar properties of the gluten present.

"The starch which forms . . . the main part of the wheat kernel is likewise of great value, not only in the

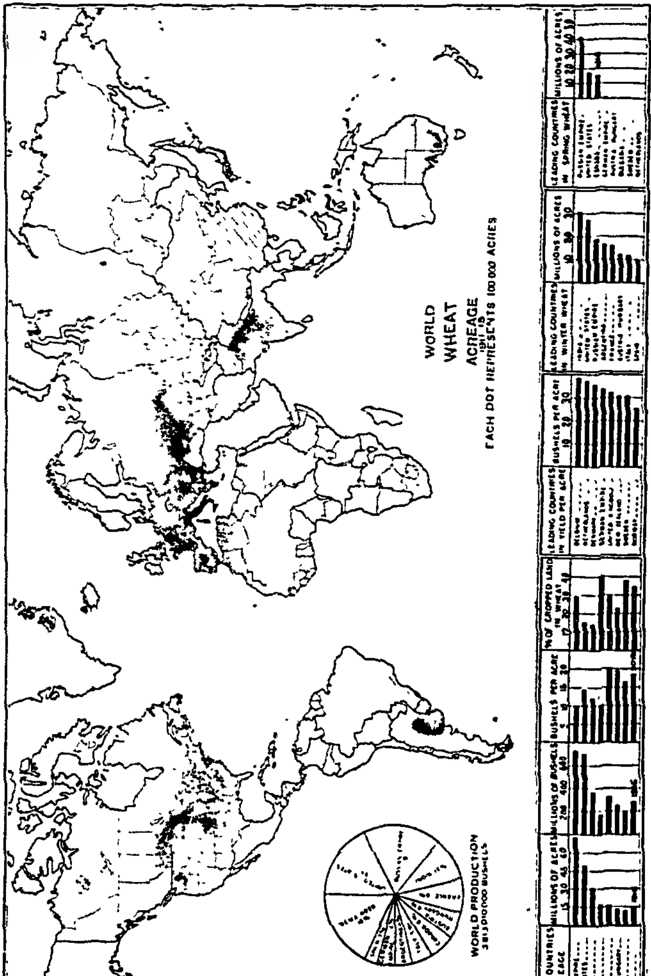

Fig. 23.—Map Showing Distribution of World's Wheat Acreage.
By courtesy Finch and Baker. Canadian Statistics revised.

foods above mentioned, but also by itself when separated as a pure product. Wheat starch is extensively used as a material for paste or sizing in various manufactures.

"Just as the inner part of the kernel is invaluable for human food, so the outer part, or 'bran', which includes bits of hull and adhering particles of seed food, is one of the very best feeding stuffs for domestic animals. The straw, both green and ripe, is also widely used for the same purpose."

62. Where the World's Wheat is Grown.—*"The world map (Fig. 23) shows eight important and distinct wheat regions: (1) The plains of southern Russia and the Danube valley, (2) the countries bordering the Mediterranean, (3) northwestern Europe, (4) the central plains of the United States and Canada, (5) the Columbia Basin of the United States, (6) northwestern India, (7) Argentina, and (8) southern Australia. The Mediterranean and northwestern Europe regions export practically no wheat because of dense population and large local demands. In five of the six regions of surplus production the population is sparse, the type of agriculture extensive, the land relatively cheap, and wheat is free in large measure from the competition of more productive crops.

63. The European Wheat Crop.—"Practically all the wheat in western and southern Europe is autumn sown. Even in northwestern Europe and the Carpathian region severe winter temperatures are infrequent, and in the Mediterranean countries the mild, moist winters and dry summers furnish favorable conditions for the winter crop. In Hungary and in Roumania, however, there is

* Sections 62 to 69 from "Geography of the World's Agriculture", by Finch and Baker, through courtesy of the authors.

some spring wheat sown. In Russia the area in winter wheat is comparatively small, except in the Caucasus and in the Crimea. Nevertheless, Russia aggregates a greater acreage of winter wheat than any other European country, with France a close second. In winter-wheat production three countries, France, Austria-Hungary, and Italy, outrank Russia. The yield per acre in France and Hungary is almost twice that in Russia.

"The great centre of spring-wheat acreage in Europe is in southern and eastern Russia, including the chernoziom, or "black-earth", region. In this region the moderately low rainfall and seasonal extremes of temperature correspond with the climatic conditions found in the spring-wheat regions of the United States and Canada. The absence of wheat from the districts around the Caspian Sea is due both to aridity and to extensive salt marshes. . . . Small quantities of spring wheat are raised in Germany, Austria-Hungary, Roumania and Sweden. The yield per acre in the countries of western Europe is, however, three times that in Russia.

64. The United States Wheat Crop.—"In the United States the most important centre of production of winter wheat is in central Kansas, extending northward into Nebraska and southward into Oklahoma. Other important producing areas are located in southwestern Illinois, southern and eastern Indiana, southern Michigan, Ohio, southwestern Pennsylvania, and the adjoining States of Maryland and Delaware, and in eastern Washington and Oregon. In the humid eastern United States the southern boundary of the winter-wheat belt follows the isotherm of 68° during the two months preceding harvest (June 15). Early-maturing varieties are a necessity along this southern margin, because of the greater dam-

age to late varieties by rust, a week's difference in time of harvest often reducing the yield 10 or 12 bushels per acre. The northern frontier of winter wheat follows in a general way the mean winter temperature line of 20°, which extends in a northwesterly direction from southern Wisconsin and northern Iowa diagonally across South Dakota and Montana. A little winter wheat, however, is grown in the Red River Valley in North Dakota, where the mean winter temperature falls to 5°.

"The important centre of production of spring wheat in the United States is in Minnesota and the Dakotas, with a secondary centre in the Palouse and Big Bend districts of eastern Washington. These four States produce over 90 per cent. of the spring wheat grown in the United States. A little spring wheat is grown in northeastern Maine, in New York, in Wisconsin, Iowa, Nebraska, and in all the Western States, but its production in these States is comparatively insignificant. . . . As a money crop in the corn belt, winter wheat is more profitable than spring wheat, while for a spring grain crop, oats are preferred. Neither the oat crop nor spring wheat is distinctly profitable in this region, but oats are widely grown because of their high feed value and as a nurse crop for clover. . . ."

65. Wheat in Argentina.—"Argentina ranks fourth among the nations of the world in wheat acreage, but owing to extensive methods of cultivation it is eighth in production. It ranks second in proportion of cropped land devoted to wheat (41 per cent.). The Argentine wheat belt lies in a region of dry, open winters and moist summers. The crop is fall-sown (May to July). While generally favorable, the Argentine climate is subject to extremes sometimes detrimental to wheat. Such are the

hot, dry winds following moist, foggy weather and late frosts in early summer. Seasons of severe drought also occur, especially in the south. Offsetting these disadvantages are flat land, fertile soils and a climate which permits the land to be worked during most of the year and makes the provision of winter food and shelter for work animals largely unnecessary. Until 1877 not enough wheat was produced in Argentina for home use, but now, in spite of low yields (10 bushels per acre), more than half of the average crop is exported.

66. The Wheat Crop of India.—"Wheat ranks third among the crops of India, following rice and the grain sorghums, but occupies less than 14 per cent. of the land in crops. Three-fourths of the total wheat of India is produced in the northwestern provinces. It is sown in October, following the cessation of the monsoon rains. The time of harvest depends upon the warmth of the winter—in the Punjab, April or May, while to the east and south, March and February are the harvest months. The wheat belt lies in the region of greatest temperature extremes. The annual rainfall varies from 7 inches in the lower Indus Valley to 40 inches in the central Ganges Valley, of which less than one-fourth falls in the winter season. In the Punjab nearly one-half of the wheat is grown under irrigation. The grain is often grown mixed with other crops and is reaped by hand. Although rice and sorghums are the chief food crops, wheat is required as a supplementary crop. The amount exported varies with the home demand and does not average more than one-sixth of the total production.

67. The Australian Wheat Crop.—"Australia leads in the proportion of cultivated land in wheat (57 per cent.). It ranks tenth in acreage and eleventh in production.

Wheat is limited to a narrow belt, between the desert and the mountains, mostly prairie land, having a low annual rainfall (12 to 25 inches), with a winter maximum. The inner margin of the wheat belt is determined by aridity, and its outer limits by increasing humidity and mountain topography. Wheat is very little grown on the east coast, in the small area of southwestern Australia having over 30 inches of rainfall, and in Queensland, except the southern portion. The farms of the Australian wheat belt are large, usually over 300 acres, only a part of which is devoted to grain. The best wheat lands are red, friable loams, formerly timber and scrub lands. They are easily tilled and, in the absence of abundant labor, cultivation and harvest are performed by machinery. As in Argentina and Canada, small population accounts for a small home demand and over half of the crop is exported.

68. The Wheat Crop of Egypt.—"Egypt was an important wheat producer in ancient times. The entire crop is raised under irrigation. Owing to its ability to thrive in a dry atmosphere, wheat grows farther up the Nile Valley than either cotton or corn (maize). Wheat is sown as a winter crop, during November, and is irrigated about 35 days after sowing and once at a later date. Harvest comes in May and June.

69. The Wheat Crop of Canada.—"Wheat is Canada's most important crop. It covers 36 per cent. of the land in crops and forms 25 per cent. of the value of all crops. The centres of production are in the plains provinces and the peninsula of Ontario, the former being by far the more important. Saskatchewan alone has more than one-half of the wheat acreage of the Dominion and ranks highest in the value of wheat relative to that of all crops.

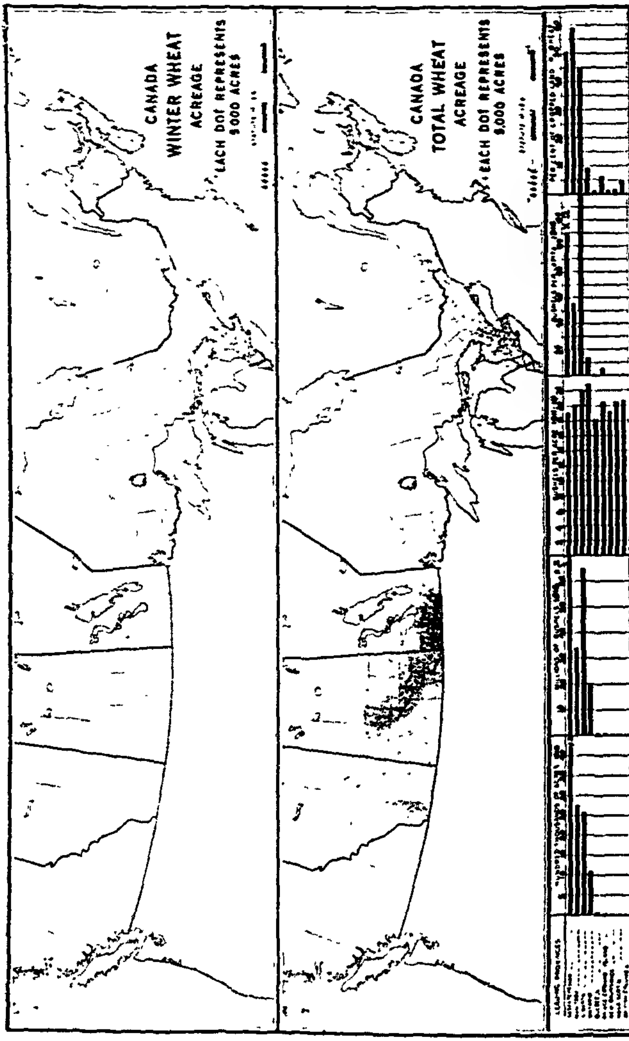

Fig. 24.—Acreage of Winter Wheat in Canada (above) and Total Acreage of Wheat in Canada (below). After Finch and Baker Statistics revised.

Manitoba and Alberta together have more than three-fourths of the balance.

"The Canadian crop is mainly spring-sown, but winter wheat is found in Ontario and Alberta, and a small acreage in Manitoba. In Ontario the heavy snows and lack of extreme winter temperatures favor winter wheat. High rainfall (30 to 40 inches) and humidity produce also a soft wheat. Southern Alberta, owing in part to the warming influence of the Chinook winds, has a shorter and milder winter than the other western provinces. Owing to the dry climate the wheat is very hard. (The small amount of winter wheat grown in Manitoba is produced in the wooded parts of the north, chiefly in the Swan River Valley. Owing to the semi-humid conditions this wheat is 'piebald', or at best semi-hard.) The great wheat belt of Western Canada is limited on the north by a short growing season and low summer temperature, and on the southwest by insufficient rainfall.

"The small population of Canada does not require the entire supply of wheat produced. On the average over one-half of the crop is exported and the exportable supply is increasing annually. At the same time Canada has the highest per capita consumption of wheat in the world (16 bushels, including wheat used for seed)."

70. The Western Canadian Wheat Crop.—The wheat crop of Western Canada is at present largely confined to the open plains region of the Prairie Provinces. This area has been found cheaper to "break" and being less liable to early fall frosts, has been the first to be developed for wheat growing. The map (Fig. 24) shows the distribution of winter wheat and the total wheat acreage of Canada. It will be noticed that over ninety-five per cent. of the crop in the Prairie Provinces is spring wheat. In

Southern Alberta rather more than ten per cent. of the crop is winter wheat. In northern Manitoba a very small acreage of winter wheat is grown around Swan River.

In all the prairie areas the wheat is very hard and of high quality when satisfactorily matured. This applies to both the spring and winter types. The spring wheat grown in the park belt is likely to be piebald or semi-hard, and the winter wheat at present grown in the Swan River Valley is of similar texture.

71. The History of Wheat.—The geographical origin of wheat, as well as the time when it became a cultivated plant, has never been definitely determined. It is believed, however, that its cultivation is much older than the history of man, and that at the dawn of history it was indigenous in western Asia.

Hunt[1] states that "very ancient monuments much older than the Hebrew scriptures show its cultivation already established. . . . The earliest lake dwellers of Switzerland cultivated a small grained variety of wheat as early as the stone age. The Chinese grew wheat 2700 B.C. . ."

De Candolle[2] believed the Euphrates Valley was the principal habitation of wheat in prehistoric times. He says: "The area (in western Asia) may have extended towards Syria, as the climate is very similar, but to the east and west of western Asia wheat has probably never existed but as a cultivated plant anterior . . . to all known civilization."

Carleton[3], discussing the present range of wheat, says: "The sub-species of wheat have a range of cultivation throughout the world, both as to elevation and latitude, greater than that of any other cereal, and probably

[1] "Cereals in America".
[2] "Origin of Cultivated Plants".
[3] "The Small Grains".

greater than that of any other crop, except that barley is grown at a slightly higher latitude and in some instances at a higher elevation. Wheat is now grown successfully in practically the hottest and coldest of civilized countries—in the tropics of the Philippines, Equatorial Africa, Brazil and Costa Rica, and near to the Arctic Circle in Europe and North America. In 1911 British East Africa began supplying wheat almost sufficient for its own needs, and the crop also did well in

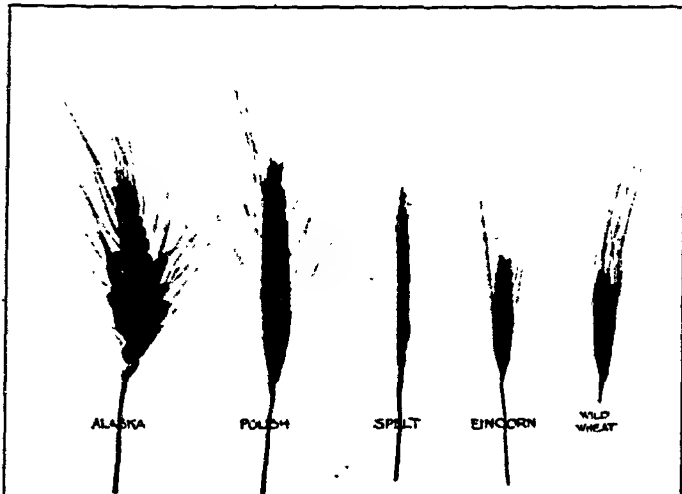

Fig. 25.—Representative Varieties of Wheat Now Seldom Grown.
Alaska (T. Poulard), Polish (T. Polonicum), Spelt (T. Spelta), Eincorn (T. Monococcum), and Wild Wheat (T. Hermonis).

Uganda and Nigeria. The Scoptsi people have succeeded with wheat and other cereals north of Yakutsk in Siberia. In Finland and Scandinavia even winter wheat reaches over sixty degrees north. At Fort Vermilion, almost 600 miles north of the latitude of Winnipeg, a flour mill has

been in operation many years. Anega wheat thrives near Archangel; while Romanov and Fife mature grain in 100 days at Fairbanks, Alaska, two degrees from the Arctic Circle."

Fig. 26.—Most Important Species of Wheat.

Leading varieties of the most important species of wheat Marquis (Triticum Vulgare), a hard red wheat, Kubanka (T Durum), a macaroni wheat and Club (T. Compactum), a soft white wheat

72. Classes and Types of Wheat.—*The cultivated varieties of wheat have been grouped by some botanists into eight species and sub-species, as follows. *Triticum vulgare* (common wheat), *T. compactum* (club wheat), *T. durum* (macaroni wheat), *T. turgidum* (Alaska and others), *T. polonicum* (Polish wheat), *T. spelta* (spelt or spletz), *T. dicoccum* (Emmer), and *T. monococcum* (one-grained wheat). Common wheat, Polish, and Monococcum are considered to be distinct species in all classifications, the other five often being classed as sub-species of common wheat. Three only

* Adapted from Carleton's "Basis for the Improvement of American Wheat".

of the above species and sub-species will be considered here, because they are relatively of much the greatest importance. These are comon wheat, club wheat and macaroni wheat.

73. The Bread Wheats.—The common wheat and club wheat groups (especially the former) are the most widely distributed groups of wheat in the world and are represented by a greater number of varieties than all the other species taken together. These are usually spoken of as the "bread wheats."

T. vulgare, or common, wheat, is generally divided into a number of botanical sub-species and varieties based upon the presence or absence of beards, the nature and color of the chaff or the color and quality of the grain. For our purpose, however, an economic classification is more useful. There are five great subdivisions of the species, based not upon botanical characters, but upon hardiness, earliness and physical qualities, as follows: (1) soft winter wheats, (2) hard winter wheats, (3) hard spring wheats, (4) white wheats, and (5) early wheats.

74. Soft Winter Wheat.—The soft winter wheats vary in color of grain from amber to white, and are produced under the influence of considerable moisture and mild, even temperatures, and are distributed in the eastern United States and Canada, western and northern Europe, Japan, and in portions of China, India, Australia, and Argentine.

75. Hard Winter Wheat.—The hard winter wheats are red-grained, usually bearded, possess a relatively high gluten content, and are more limited in their distribution. They are grown usually on the black soils and

under the influences of a climate characterized by extremes of temperature and moisture, but especially by dry, hot summers. They are found chiefly in Kansas, Iowa, Missouri and Oklahoma, in the United States, in Hungary and Roumania, in southern and southwestern Russia, and to some extent in the Western Provinces of Canada, northern India, Asiatic Turkey and Persia.

76. Hard Spring Wheat.—The hard spring wheats are generally red-grained and rich in gluten content, and are adapted to conditions of soil and climate identical with those just mentioned for hard winter wheats, with the exception that the growing season is shorter and the winters too severe for winter varieties. They are found in Central and Western Canada, the northern part of the plains of the United States, Eastern Russia and Western and Southern Siberia.

77. The White Wheats.—The white wheats are, with some exceptions, soft and very starchy, but possess grains a little harder and much drier than those of the soft winter wheats. They are either fall or spring sown, and are sometimes sown in both seasons in the same locality. They are grown chiefly in the Pacific Coast and Rocky Mountain States, in Australia, and in Chili, Turkestan and the Caucasus.

78. The Early Wheats.—The early wheats are often soft or semi-hard, and generally amber to red in color of grain, but they are distinguished from the other types chiefly by their ability to ripen early. They are found in Australia and India, are represented by a very few varieties in the southern States of the United States and include some of the dwarf wheats of Japan.

79. Varieties of Common Wheat.—The varieties of the species *vulgare* naturally include the most diverse char-

acters, because of their long cultivation under so many different conditions. Their greatest characteristic, as a whole, however, is the well-known quality of producing

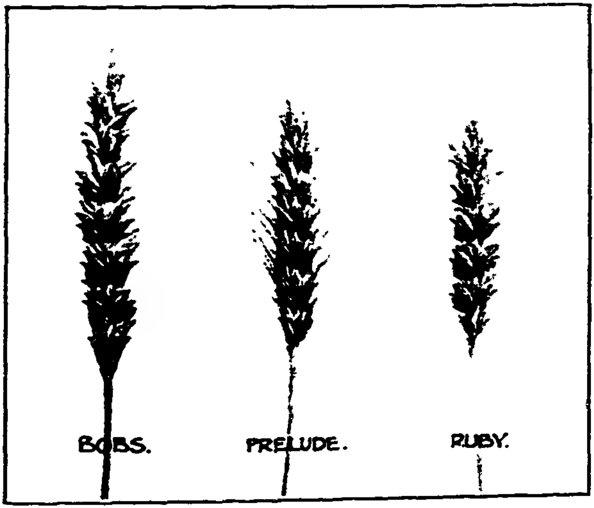

Fig. 27.—Some Promising Early Wheats for Northern Parts.

a light loaf. For this reason the term "bread" wheats is usually applied to them. Nevertheless, it should be noted that the difference between the best and poorest sorts of this species for bread-making is fully as great and sometimes greater than between some varieties of different species. The hard, red-grained varieties are considered best both in respect to their protein content and our present system of roller milling. They include Red Fife, Marquis, and Blue Stem, Turkey, Mediterranean and Fulcaster of Canada and the United States; the Ghirkas, Ulka, Crimean and Buivola of Russia; and the Theiss and Banat of Hungary and Roumania.

On the other hand, the white wheats and soft winter wheats give the best results in the manufacture of crackers. Several of the most popular breakfast foods are also made from white wheats. A small amount of macaroni is made from the hard spring wheats and the white wheats, but no varieties of the common wheat group are well adapted for this purpose.

80. Qualities of Common Wheat.—The special qualities that are found in varieties of *T. vulgare* may be summarized as follows:

(1) Excellence of gluten content for bread-making.
(2) Excellence of certain varieties for cracker-making.
(3) Yielding power of certain sorts.
(4) Hardy winter wheats.
(5) Resistance to drought (in some varieties).
(6) Early maturity (in some varieties).

81. The Club or Square Head Wheats (*T. compactum*).—Besides producing the class of flours desired in certain localities, club varieties are very good for cracker-making and for the more starchy kinds of breakfast foods. They are grown either as spring or winter varieties, except in Turkestan, where the winters are too cold for fall sowing.

Club wheats are at present cultivated chiefly in the Pacific Coast and Rocky Mountain States of the United States, in Chili, Turkestan, and Abyssinia, and to a slight extent in Switzerland, Russia and some other local areas in Europe. The special qualities of the group are as follows:

(1) High yielding power.
(2) Stiffness of straw.
(3) Freedom from shattering.

(4) Early maturity (in some varieties).
(5) Drought resistance (in some varieties).
(6) Excellence of certain varieties for cracker-making and breakfast foods.

82. The Marconi Wheats (*T. Durum*).—The durum group furnishes the great bulk of the world's supply of macaroni, though a considerable amount of these pastes is made from Poulard and Polish varieties and a small

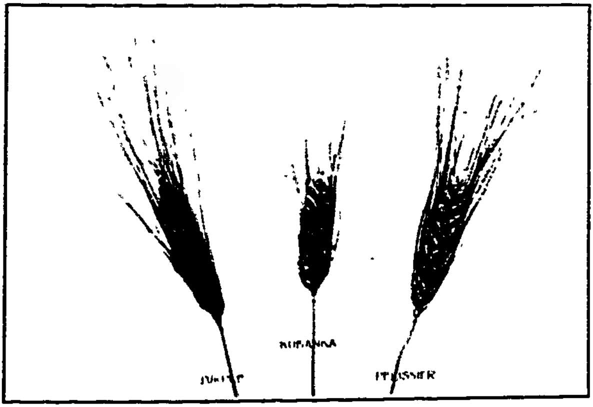

Fig. 28.—Three Varieties of Durum Wheat.
(See also Fig. 48).

quantity from the common bread wheats. There is now not the least doubt that some of the durum wheats used for macaroni can be more successfully grown in parts of Canada and the United States than the common wheats. The idea that they cannot be satisfactorily used for bread is also being found erroneous. Durum wheats are now being quite extensively used for bread-making in parts of the United States and southern Russia. The low quality of the gluten for bread-making and the yel-

low color of the loaf are the chief causes of the prejudice against this class of wheat in America.

Durum wheats are adapted to soils rather rich in nitrogenous matter, and somewhat alkaline, and give the best results in a hot, dry climate. They are quite drought resistant.

Almost all varieties are adapted only for spring growing, except in mild latitudes. They are grown in Spain (where they predominate over all other groups) and other Mediterranean countries, in south and east Russia, Asia Minor, in the semi-arid States of the United States, and to some extent in Mexico, Chili and Argentine.

The special qualities possessed by this group are briefly:

(1) Excellence of gluten content for making macaroni and other pastes.
(2) Resistance to drought.
(3) Resistance to rust.
(4) Resistance to shattering.

83. The Relative Yield of Different Varieties.—Fig. 29 gives the relative yield of the different leading varieties of wheat at Saskatoon, based on a seven years' test. The wheat was sown on either breaking or fallow. When sown on stubble the yields were smaller, but bore the same relation to one another, except that (1) there was a greater difference in favor of Kubanka, (2) Red Fife yielded more than Marquis, and (3) Reb Bobs was relatively lower in yield. Some of the low-yielding varieties are very early and may therefore be expected to yield relatively better in areas having a shorter growing season than Saskatoon.

84. Varieties Recommended by the Dominion Cerealist.

—As a result of tests made at the Brandon, Indian Head, Lethbridge, Lacombe, Scott and Rosthern Experimental Farms the Dominion Cerealist recommends the following varieties for each of the Prairie Provinces:

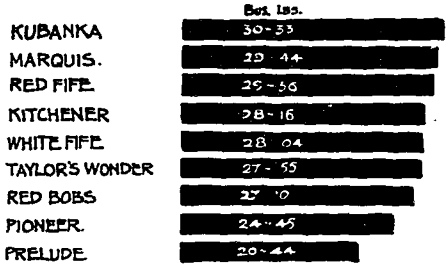

Fig. 29.—Relative Yields.
Chart showing relative yield of different varieties of wheat at Saskatoon.

For Manitoba.—Marquis and Red Fife for most localities, the former for districts where early frosts are feared, the latter where Marquis grows too short a straw. In some localities Marquis should be sown only on summer fallowed land. He considers Ruby and Prelude worthy of trial wherever Marquis produces too long a straw or ripens too late.

For Saskatchewan.—He states that Marquis, Red Fife, Early Red Fife, Pioneer, Ruby, Prelude and Kubanka should all be considered. Marquis is the most productive and is the best variety for many districts, especially on summer-fallowed land. Where Marquis proves too short in the straw, Red Fife or Early Red Fife should be grown. Where Marquis grows too rank and is too late in ripening, Pioneer, Ruby or Prelude may be found very valuable. Pioneer is a new variety for dry districts where early ripening varieties are necessary. It is not recommended for test where the rainfall is good.

For Alberta.—He recommends Kharkov and Turkey Red winter wheats. He considers that these two are essentially the same in most respects, but that Kharkov has shown greater productiveness in some tests.

Among spring wheats he believes Red Fife is the best sort for some of the dry areas towards the south, but that wherever there is sufficient rainfall, Marquis should be grown. If early maturing varieties with longer straw than Marquis are essential, Huron and Early Red Fife are suggested for trial. Pioneer is recommended for dry districts where early maturity is desired, and for short-season localities where the tendency is toward the production of excessively short straw. Where a very early-ripening wheat is required, Ruby and Prelude are considered the best varieties.

Fig. No. 30.—Table showing five years' average yields of different varieties of wheat at different stations—figures for each station are comparable, but are not necessarily so between different stations.

	Brandon		Indian Head		Saskatoon 1911-17 incl.		Scott		Rosthern		Lethbridge 1913-15 incl.		Lacombe 1912-15 incl.	
	bus.	lbs.	bus.	lbs.	bus.	lbs.	bus.	lbs.	bus.	lbs.	bus.	lbs.	bus.	lbs.
Marquis	46	35	60	27	29	44	27	06	51	14	37	33	49	34
Red Fife	36	37	42	25	29	36	25	58	42	20	40	18	55	45
Pioneer	..	..	..	..	24	45	23	57*	36	47*	32	35	..	..
Prelude	30	17	37	42	..	..	20	23*	26	00*	20	25	39	10
White Bobs	..	..	..	..	..	..	..	..	49	38	37	10	57	21
Huron			..	..	..	..	27	42	50	04	42	45	57	22
Kubanka	..	..	..	..	30	33	..	..	34	47*	44	30	..	..

* 3-year average, 1913-15

85. The Milling Quality of Different Varieties.—Flour is the most valuable mill product obtained from wheat, hence the percentage of flour derived is a factor of great importance. Very little data on this point is available. The following table, showing the average per cent. of flour and other mill products derived from wheat during

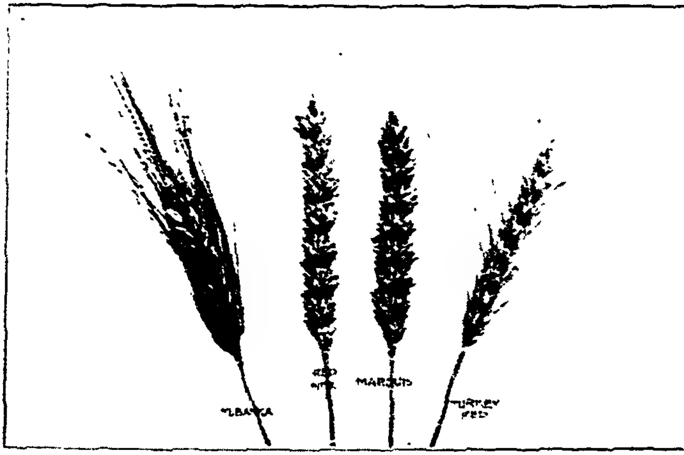

Fig. 31.—Leading Spring and Winter Varieties of Wheat.
Turkey Red is a winter wheat; the others spring sown varieties.

many tests covering the eight years, 1907 to 1914, inclusive, at the North Dakota Experiment Station, gives the best available information:†

Variety	Number of samples	Per cent flour	Per cent bran	Per cent shorts	Loaf vol. in c.c.
Fife	75	69.60	12.35	15.60	2373
Bluestem	325	69.78	13.93	13.93	2419
Marquis	26	71.04	15.15	14.73	2499
Velvet Chaff ..	59	67.11	12.80	17.27	2298
Winter Wheat .	38	69.86	13.69	14.53	2295
Durum	127	69.01	8.76	19.14	2071

* 1913 and 1914 only.

86. The Baking Quality of Different Varieties.—The chief qualities that at present determine the baking value

† From Bulletin No. 114, North Dakota Experiment Station, Fargo.

of flour for bread-making are the color, water absorption and volume of loaf. The following table summarizes the data with respect to these points and also the flour yield for several varieties grown under comparable conditions at Saskatoon during each of the three years, 1914, 1915 and 1916:

Variety.	Yield of flour in per cent	Color of flour	Wet gluten in per cent.	Vol. of loaf in cu. inches.	Absorption in ounces.
Kubanka	75.97	yellow white	42.47	168	7.46
Marquis	75.74	creamy white	40.47	196	7.51
Red Fife	75.30	creamy light white	43.04	183	7.39
*White Fife	71.3	white cream light dull	42.00	202	7.00
Pioneer	74.74	creamy white light gray	48.14	197	7.20
Prelude	74.5	creamy dull white	51.8	198	7.00
Taylor's Wonder	74.04	light cream	34.00	201	6.96
Buffum's No. 17 (winter)	73.50	creamy light white	41.47	166	6.63
Alaska	73.97	yellow white	37.57	150	7.58

*Average for two years only.

The color of flour is important from the commercial standpoint, as both the housewife and the baker prefer a white flour for bread-making.

The absorption or quantity of water used per unit of flour bears a very important relationship to commercial worth, as, other things being equal, the more water that can be worked into a given weight of flour the more bread it will make. This is, of course, of particular interest only to the commercial baker.

The volume of loaf refers directly to what is termed the "baking strength" of a flour. This characteristic is of greatest importance to the baker. He recognizes that

a dough to yield bread of good quality, including size, and uniformity of the "pores" or crumb texture, must be elastic. The greater the elasticity the larger the

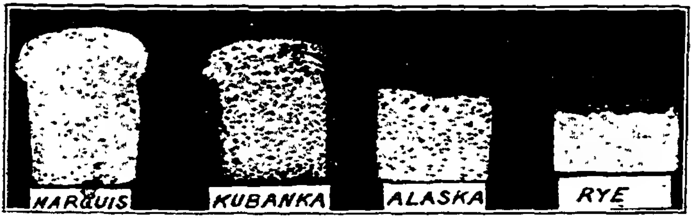

Fig. 32.—Loaves Showing Characteristic Differences in Volume.

Marquis is a standard western sort. Kubanka is a "macaroni" wheat, the loaves from which are relatively small in volume and yellowish in color: Alaska is a much exploited variety but lower in baking strength than any other tested. The rye loaf is characteristic of the low volume and close texture of rye bread.

volume of the loaf, and consequently the greater its "baking strength".

It will be noticed that in most cases the flours that are high in wet, crude gluten, as a usual thing, yield loaves larger in volume. This does not always hold true however. The Durum flours as represented by Kubanka, carry a high percentage of gluten, but the loaf is seldom exceptionally large, owing to the low "quality" of the gluten.

Numerous tests emphasize the fact that wheats of the Marquis and Red Fife type conform very closely to the demands of the miller, baker and exporter. They seem to possess in an unusual degree the desired composition and quality not only for use alone but also for mixing with flours of lower "strength".

87. The Earliness of Maturity of Different Varieties.— The average date of maturity of different varieties grown at Saskatoon during the years 1911 to 1917 is indicated

in Fig. 33. The first five varieties were not grown every year, but the table gives their relative earliness, based on their behavior in the years they were grown. From this it will be seen that Prelude and Ruby are our earliest varieties, Red Bobs and Pioneer about four or five days later, Marquis about eight days later, and the Fifes and Kubanka ten to twelve days later on the average.

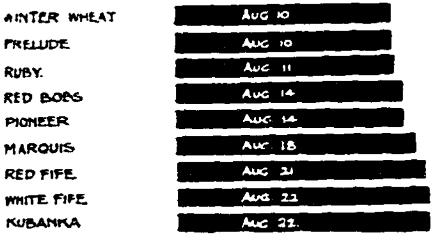

Fig. 33.—Dates of Maturity.
Chart showing relative earliness of different varieties of wheat at Saskatoon.

88. The Leading Varieties.—The following are among the best spring sown varieties at present available for western conditions. New sorts are, however, appearing from time to time. The grower would do well to keep in touch with his nearest experiment station in order that he may be kept aware of the relative value of new introductions as compared with the old standard sorts.

Red Fife.—High in quality, long straw, late in maturing, a good yielder. It is suited to the lighter and earlier types of soil, to the drier parts of the prairies, to all regions where fall frosts are not feared, and where long straw is desired.

The head is medium to long and slightly open, tapering, bald, although a few short awns are usually present, especially in the apex. It shatters slightly. The chaff is whitish yellow in color.

Early Red Fife is similar to Red Fife, except in being considerably earlier and more subject to rust. The seeds are rather larger and the heads more blunt.

Marquis. High in quality, short straw, early in maturing, non-shattering, good yielder. This variety is likely to give more satisfactory returns than Red Fife on heavy soils, on fallowed land, in moist regions, where fall frosts are feared, and in those areas where a shorter straw is preferred.

The head is medium long and slightly compact, pointed, bald, in some instances a few conspicuous awns are present. The chaff is whitish yellow in color. The seeds do not shatter easily, sometimes being held so tightly that complete separation in threshing is difficult. The seed is very heavy, dark red, rather short and blocky, and medium in size.

Pioneer.—High in quality, long and weak straw, earlier than Marquis, fair yield. It is a good wheat for all regions where Marquis is not early enough and where the crop seldom lodges.

The head is medium to short and rather open, tapering, and bearded. The chaff is whitish yellow in color. The seed is medium heavy, pale, dark red in color, medium long and tapering, small sized, and shatters slightly.

Ruby is less productive than either Marquis or Pioneer, but several days earlier. The heads are bald and the chaff and straw deep bronze to reddish in color, is less liable to shatter than Prelude, is nearly as early as the latter, but rather taller and more productive.

Prelude.—High in quality, but only fair in color of flour, short straw, earlier than Pioneer, bearded, shatters easily, low in yield. This variety may be found satisfactory in regions north of the present wheat-growing area, but on account of its low yield it is not worthy of a place in districts where Marquis matures.

The head is short and rather open, bearded, chaff

brownish yellow in color, shatters very easily. The seed is medium heavy, dull reddish in color, rather short and tapering, and small sized.

Red Bobs.—A new wheat, earlier than Marquis, quite high in quality and yield. It seems to be a promising early wheat for northern areas, although reported to be somewhat less resistant to rust than Marquis and rather lower in baking quality.

The heads are of medium length and rather compact, beardless, showing no sign of even short beards. The chaff is whitish yellow in color. The seeds are medium in size and weight, light red in color and pointed oblong in shape.

Durum Wheats.—Kubanka and Pelissier are the two most promising "macaroni" wheats. Both are high yielding, drought resistant and productive, and some strains are rust resistant. Kubanka is generally rated higher than Pelissier in baking quality. Heads bearded, seeds large, long and very hard. Recommended for trial in the drier parts of southern Saskatchewan and Alberta and in the Red River Valley.

The heads are rather short and very compact. They are bearded, have brownish yellow chaff, and are non-shattering. The seed is medium to heavy in bushel weight, bright yellow in color, long and narrow in shape, and of large size. Pelissier has black beards and very large seeds while Kubanka has bronze beards and smaller seeds.

89. Some Varieties that have been Discarded.—The hybrid wheats—Preston, Stanley, Huron, Percy, Bishop and Chelsea—were discarded at most stations because of low milling or baking qualities. They were all early and quite productive. Huron is still being grown in some areas.

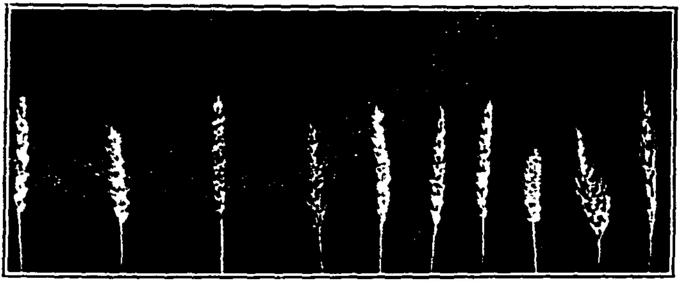

Fig. 34.—Varieties That Have Not Stood the Test.
These have been discarded by most experiment stations in Western Canada. (1) Bluestem, (2) Preston, (3) Stanley, (4) Huron, (5) Chelsea, (6) Percy, (7) Bishop, (8) Club, (9) Alaska, (10) Polish.

The "*Blue Stem*" wheats of the Dakotas have been discarded on account of lateness in maturing and a tendency to shatter.

"*Club*", the chief wheat of the Pacific Coast region, has been discarded because of its low baking value.

The "*Polish*" wheats used in some southern European countries are inferior in yield and quality to both the common and Durum types.

The "*Poulard*" wheats, as represented by "Alaska" or "Seven Headed" or "Miracle" or "Egyptian King", are superior in no desirable quality and are the poorest milling wheats we have ever grown.

Speltz, a late, coarse-strawed wheat which retains its hull when threshed, is low in yield and generally unsuitable for use here. (See Emmer, in Sec. 90).

90. Some Unpopular Varieties that may be found Useful.—

Emmer, an early ripening, drought resistant "feed" wheat, which retains the hull when threshed, may find a place in the drier Chinook areas as a partial substitute for oats. It is quite drought resistant.

White Fife is almost identical with Red Fife in all important qualities, but has a white bran, against which there is a very marked prejudice, due to the somewhat

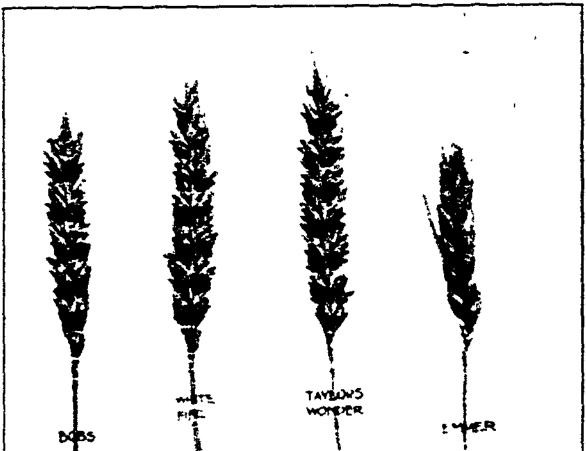

Fig. 35 **Some Unpopular Varieties That May be Found Useful.**

similar outward appearance of hard white and soft white wheats.

Bobs is a white Australian wheat, rather earlier than Marquis, and often more productive, but shorter in the straw. Although white, it is very high in milling and baking qualities.

Taylor's Wonder is a white wheat, longer in the straw than Marquis, rather later, semi-hard, very productive in some seasons, rather subject to rust, but a wheat of fair milling quality. Taylor's Wonder and Bobs offer some promise in breeding work.

91. How to get the Best Seed.—When starting to grow wheat in any community in the West, four facts should

be ascertained if possible, either from the experience of other farmers or from meteorological reports, or from the nearest experimental farm. These are, (1) the average and extreme dates of the first fall frost, (2) the average precipitation, (3) whether winter wheat will withstand the winter, and (4) the kind of soil.

Where the fall frosts come very early only the earliest sorts should be used—short-strawed early ones on heavy land, and long-strawed early ones on light land. Where the average precipitation is high the shorter-strawed early varieties should be used, but where it is low the long-strawed ones will be found best. Where winter wheat will come through the winter satisfactorily three times out of four it should be grown. In humid districts having a short growing season and a heavy soil the earliest short-strawed varieties are best. In proportion as the fall frosts are early, the precipitation high and the soil heavy or well stored with water, early varieties will be found best. As these conditions are departed from later varieties should be used.

Pure seed of the chosen variety, free from admixture and from weeds and disease, can usually be secured in small quantities from the nearest Experimental or Demonstration Farm or College of Agriculture. Registered seed from a member of the Canadian Seed Growers' Association is likely to be as good as one can obtain. Even a small supply of the right kind, if it is free from weeds, admixture and disease, and will germinate vigorously, is much to be preferred to a larger quantity if the latter is wanting in any of these qualities.

92. How to Maintain the Purity and Vigor of Good Seed.—If a farmer has a mixed sort he should either purchase new seed or endeavor to purify what he has

by selecting desirable heads from his field or by rogueing out the undesirable ones from a plot set aside for seed. If he has a pure variety that is actually free from dis-

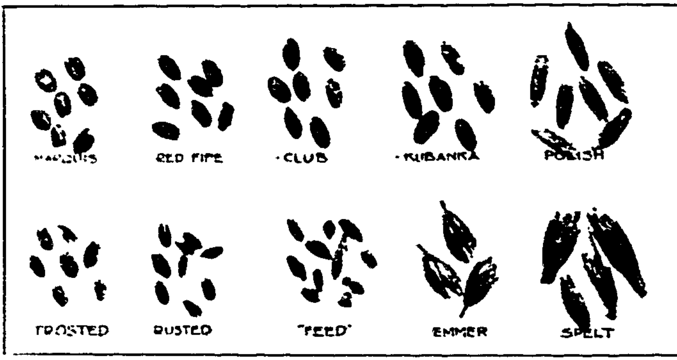

Fig. 36.—Seeds of Several Kinds of Wheat and Samples of Frosted, Rusted and Feed Wheat.

ease he can hardly hope to "improve" it, but he should aim to *maintain* its present high standard of purity, health and productiveness by the selection of typical healthy plants or heads, or at least by "rogueing" his seed plot.

93. The Improvement of Wheat by Selection.—The term, selection, as ordinarily used, may refer to any one of three different methods of improvement.

First, selection of the seed as by the use of the fanning mill.

Second, the mass selection of heads as practised by members of the Canadian Seed Growers' Association.

Third, individual plant selection as followed by a few seed growers and most breeders.

Each of these methods has some advantages and some limitations.

94. Selecting Seed with a Fanning Mill.—During the two years, 1914 and 1915, an equal weight of both well-matured, plump kernels and small, shrunken seed was removed by hand from samples of No. 1 Northern wheat. These were sown in separate plots at Saskatoon at 1½ bushels per acre in the seasons mentioned. The well-matured, plump seed yielded 37 bus. 58 lbs. per acre, while the small, shrunken seed yielded 33 bus. 11 lbs. When samples of these two separations were planted at an equal number of seeds per acre the plump, well-matured seed yielded 40 bus. 35 lbs., while the small, shrunken seed yielded 35 bus. 2 lbs. The last set of figures illustrates the fundamental principle that well-developed, plump seeds normally produce a more vigorous crop than an equal number of smaller, ill-developed ones, while the first set indicates that even at the same weight sown per acre the larger seeds, although fewer in number, returned the larger yield, a result that does not always happen.

The only practical means of applying this principle to the preparation of grain for seed is by the use of the fanning mill. In order to determine the value of the fanning mill as a means of separating the less desirable from the better seeds in a sample of No. 1 Northern wheat, some seed of this grade was thoroughly cleaned by a Clipper mill during each of two seasons. A sample of the cleaned seed, another of the original uncleaned seed, and a third of the light shrunken seed were planted with the following results:

	2-year Average Yield.
Cleaned grain	40 bus. 41 lbs.
Uncleaned seed	39 bus. 52 lbs.
Light and shrunken grain	38 bus. 15 lbs.

The fanning mill when properly adjusted and well handled will separate most weed seeds, any injured and shrunken seeds and nearly all smut balls from seed wheat, and leave the larger, plumper and heavier berries. To this extent at least its use promises clear gain. Its greatest usefulness is observed when the seed lacks uniformity and contains weed seeds or disease. Its lowest efficiency is evidenced when the grain is all well matured, as was the case in the test reported.

If the variety to be cleaned is a mixed one the strains having the largest seeds, whether desirable or undesirable, will be reproduced and those having the smaller seeds will gradually be discarded. If the mixture contains late and early sorts, the former in this climate will gradually be eliminated. In such cases the cleaning may or may not result in "better seed", depending in the first case upon whether the large seeded sorts are desirable or undesirable, and in the second upon whether the early or the late ones are the better.

The chief value of the fanning mill in pure varieties is probably to be found in the removal of dead, diseased and injured seeds, and foreign matter such as weeds, dirt, other kinds of seed, etc., rather than in improving the hereditary power of the strain through selection.

95. The Mass Selection of Wheat Heads.—The continuous selection of typical well matured heads from a mixed variety, or from a mass selected strain or from a pedigree sort that is not fixed enables one to improve its purity, to obtain greater uniformity of ripening and a somewhat greater yield of a better grade of grain. The favorable result of this practice

within a mixed race has been apparent in variety tests at Saskatoon in several seasons when different strains of Red Fife have been compared. A strain that has been selected for several years by Mr. F. J. Dash of Hillesden, Sask., has invariably yielded more than any other strains of this variety. It also shows less variation than any others except "pure line" strains.

The head selection method of improvement in a pure variety or pedigree strain that is free from disease and that "breeds true," is often very useful in preventing

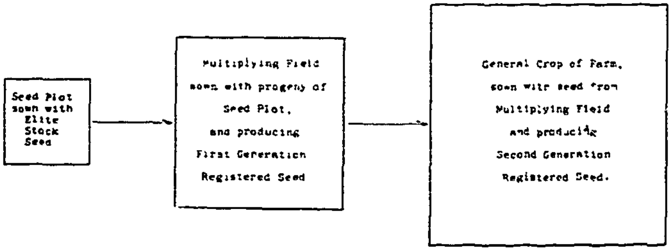

Fig. 37.—Plan of the Method of Mass Selection.
This method is followed by members of the Canadian Seed Growers Association

admixture and disease creeping in, but as a means of "increasing" the productive power of such a variety it is probably almost useless. The most that can reasonably be hoped for from it—and this is quite a sufficient argument to warrant the continuance of the practice—is that the original purity and health of the sort may be maintained, and that its productiveness may not be lowered. At the same time it may be pointed out that very few of our varieties are free from disease and fewer still "breed true" and that our best bred sorts are seldom under cultivation long before they are "mixed".

In such as these, head selection is essential if purity and uniformity are to be maintained.

96. Individual Plant Selection.—In this method of improving wheat, the plant is taken as the unit rather than the head or the seed. It is the most advanced method of selection but unfortunately it is not a practicable one for the average farmer for the reason that it involves so much labor in the selection work itself and later in keeping accurate and satisfactory records of performance. To get the best results one must study large

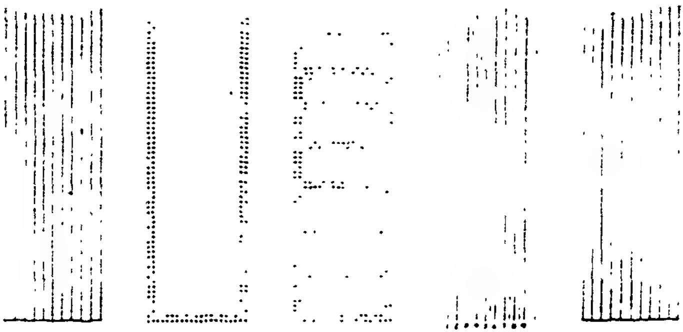

Fig. 38.—Progressive Steps in the Improvement of Cereal Crops by Selection.

The pedigree method of selection as followed at some of the experiment stations. The best varieties are found by testing in "variety" plots. Good seeds from the best variety are planted singly in 4 inch squares in the "foundation bed". The seed of each of the best plants is put in by itself the next year in small beds called "centgeners". The product of the best centgeners is sown the following season in "multiplier" plots and the best of these tested out for five years as "strains".

numbers of plants under controlled soil conditions. He must keep the progeny of each pure, then test the different strains carefully side by side for a number of years and only then increase such as are the most stable, most productive and generally the most desirable.

97. Improvement by Cross-Pollination or Breeding.—Crossing aims to combine the desirable and to eliminate the undesirable qualities of two parents. Cross pollination causes considerable variation in the second and later generations after crossing and thus gives greater opportunity for the selection of desirable plants.

98. The Wheat Flower and Fertilization.—To cross-pollinate wheat successfully a knowledge of the wheat flower and its essential parts is necessary. The most important parts of any flower are the stamens and the pistil. These are the so-called sexual organs of the plant. (Fig. 39).

In the wheat flower there are three stamens each consisting of two parts—the stalk or filament and the enlarged upper part, the anther, which contains the yellowish dust called pollen. The pollen grains are reproductive cells.

The pistil consists of an ovary and two feathery appendages or stigmas, which, when mature are sticky and thus hold the pollen grains that may fall upon them. When pollen falls upon the mature stigma, whether by natural means or by artificial "crossing" it comes in contact with the moist surface and starts to grow or elongate. An outgrowth called the pollen tube makes its way

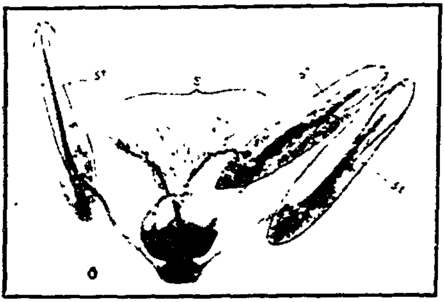

Fig. 39.—Flower of Wheat Plant.

St stamens, S stigmas; O ovary. By courtesy Journal of Heredity and A. E. V. Richardson, Victoria Department of Agriculture, Melbourne, Australia.

down through the style or stem of the stigma to the ovary — the part of the pistil which contains the female egg cells. The nuclei of the male cell pass down through the pollen tube and one of the two unites with a nucleus of the female egg cell. This union of the male and female nuclei constitutes fertilization, after which the development of the seed immediately begins.

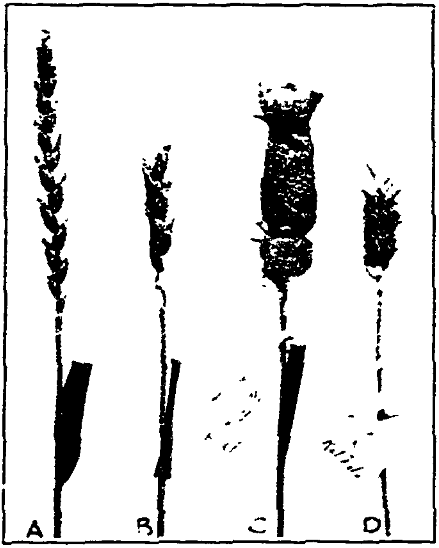

Fig. 40.— Progressive Steps in the Crossing of Wheat.
(a) Wheat spike just after heading. (b) upper and lower spikelets removed. (c) protected from foreign pollen (both after emasculation and after pollination). (d) protection removed after fertilization.

99. Emasculating Wheat.—The first step in the crossing process is what is called emasculation. This consists in removing the anthers in order to prevent self-pollination. This operation is simple and is performed before the anthers reach maturity. The glumes are easily parted and the three stamens are removed usually by a small pair of sharp pointed tweezers. The stamens stand somewhat separated but can readily be removed at one operation. Usually three to six spikelets each reduced to two flowers are used on each head of wheat, the others being removed before emasculation. The whole

head is then wrapped with cotton to protect it from foreign pollen until the pistil becomes receptive. A small numbered label is then attached on which is recorded the date of emasculation and any other notations the operator desires to make.

100. Pollinating Wheat.—As soon as the pistils of the emasculated flowers become receptive, pollen from the other parent plant is applied. In wheat the receptive condition is shown by the appearance and position of the two feathery appendages of the pistil. When receptive these are moist and feathery in appearance and widely spreading. After pollination the whole head is re-wrapped as before, to prevent possible fertilization by foreign pollen. After fertilization has taken place and the seed has started to develop, the covering is removed from the head to permit of the normal development of the seeds.

101. Procedure after Crossing.—The first plant from a seed that is the result of a cross, may, in respect to any particular character, be intermediate between the two parents but is much more likely to resemble one or the other of them. In the second generation there is much variation among the offspring. It is to induce this variation with its attendant recombination of different characters in one individual that artificial crossing is resorted to. From among the second and later generations of plants the breeder must make his selections and grow each separately for a number of years or until such time as he is assured they "breed true" and possess the economic qualities, such as yield, quality, earliness, strength of straw or disease resistance, that he desires. After securing the necessary cross it requires years of persistent effort to eliminate the undesirable, to discover

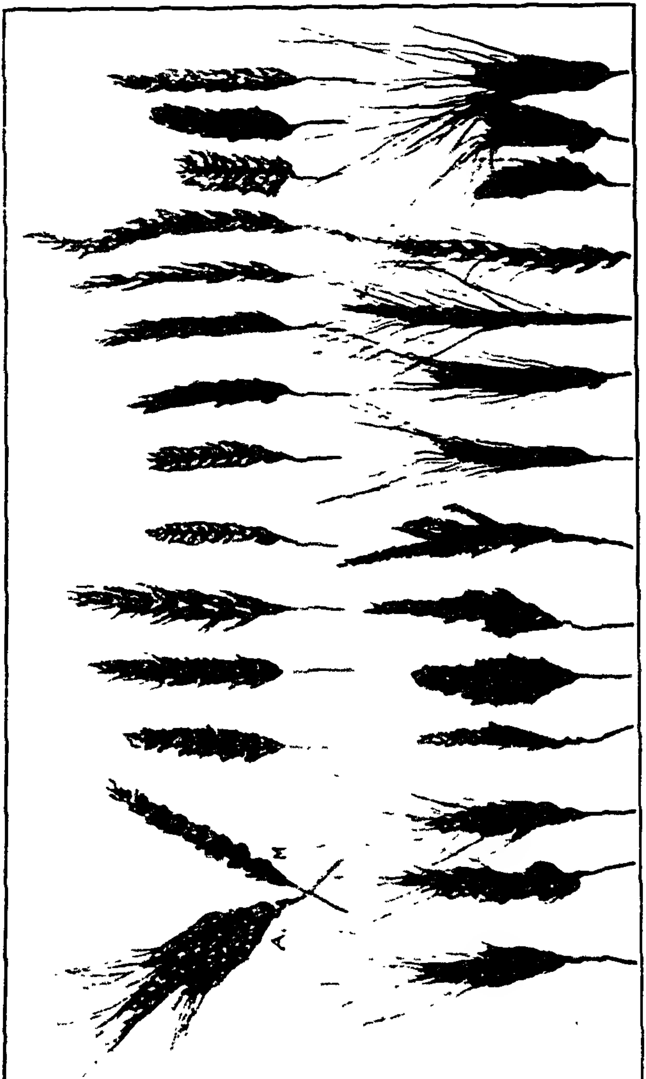

Fig. 11.—Variations Found in the Second Generation.
From a cross of Marquis on Alaska wheat. By courtesy W. P. Thompson

the useful and then to determine from among the latter the ones that have the power to produce a high yield of good quality.

102. Place of Wheat in the Rotation.—In the chief wheat growing regions of the open plains where a fallow is used, wheat is the first crop after the fallow and also the first after "breaking." In many areas it is used as the second crop as well. On some of the heavy soils, such as the "loose top" of the Goose Lake district of Saskatchewan where the first crop is likely to be late or to be attacked by wire worms, flax is used as the first crop and either oats or wheat as the second. On the rich soils of the park belt, as well as in the high altitudes of the Western prairies, where wheat is likely to be late in maturing, oats is frequently used as a first crop after fallow and wheat as the second. Wherever corn is used in the rotation wheat usually follows it. In all areas where early fall frosts are common wheat should follow some other cereal or a hoed crop, or a pastured fallow or grass land.

In this connection it is interesting to note the actual yield of wheat following each of several crops at Saskatoon during the years 1915, '16 and '17. (See fig. 42). The favorable results after corn suggest a more extensive use of this crop where it can be satisfactorily grown. The unfavorable results after turnips alone are not shown here but were very striking. Pea ground generally gave a good crop. Flax ground, contrary to the expectation of many, yielded rather more than wheat ground. In all cases the crop preceding the wheat was sown on fallowed ground.

103. Preparation of the Land for Wheat.—Land intended for wheat should be well stored with moisture

and available plant food, firm and as free as possible from weeds, grass and insect enemies. Of all the grain crops now grown in the West wheat requires the best preparation including the greatest supply of available plant food. This is why it does so well on "breaking", fallow land and corn ground.

The long growing season it requires necessitates an early start, for which moisture in the soil is essential. This early growth requires a supply of available plant food material which can only be assured at such an early date in the spring if developed the previous year. The soil must be firm below the mulch to permit of the quick development of roots before the dry windy weather of May. And it should be as free as possible from weeds because these lower the yield and profit.

The soil conditions that in general best meet these requirements are the fallow, "breaking" and corn ground or land having produced some other hoed crop. Fall plowing and "stubble" land are however frequently sown to wheat. Under the rotations followed at present the wheat acreage is chiefly composed of fallow and fall plowing, although considerable wheat is "stubbled in" and some sown on spring plowing. Each of these methods of preparation has some advantages and some disadvantages under different conditions of soil and climate. These may be briefly stated as follows:

The fallow is the name applied to land that has lain idle for a year, no growth of crop or weeds having been permitted, and the soil tilled in such a manner as to store and conserve moisture. The chief advantages of the fallow are in (1) its at least partial insurance against drought, (2) the development of available plant

food in the soil, (3) the destruction of weeds and weed seeds, (4) it is (on most soils) ready to sow as soon as spring opens up and (5) it permits of a better distribution of farm work.

The disadvantages of the fallow are many: (1) it results in the loss of the use of the land for a year, (2) the soil tends to drift as a result of too fine and loose a surface, (3) on heavy soils the fallow unduly delays ripening, (4) in wet seasons, particularly on heavy soils the crop is made more subject to serious rust damage, or it may lodge, (5) the necessary tillage of the fallow usually costs more than the tillage of land cropped every year and (6) fallowing causes a serious loss of organic matter and nitrogen from the soil.

The fallow is the best preparation for wheat in all the drier parts of the West where the soil does not drift, where fall frosts are not feared and where corn is not a profitable crop. In the more humid parts and in the areas of early fall frost the fallow is not in all seasons the most profitable method of preparing land for wheat.

Sod land or "breaking" is one of the best preparations for wheat. Such land generally produces an earlier and safer but a less productive crop than the fallow. Sod land is one of the best places for wheat in the zones of early fall frosts and those of higher precipitation. In the drier parts the breaking should be done in the June previous. In the more humid sections later breaking is permissible. It is seldom advisable even in the most favored parts to sow wheat on late fall or early spring breaking because of the lack of moisture in the soil. Breaking has none of the disadvantages of the fallow and has in some degree all of its advantages if well done.

Corn is but little grown in the West, but in the drier, warmer parts it may find a place as a partial substitute for the fallow and as a preparatory crop for wheat. When sown to corn in rows 36 inches apart or in hills 3 feet apart each way *and kept free from weeds*, the land the next year generally produces almost as much as a fallow. Clean corn ground seldom needs to be plowed for the next crop of wheat. A good discing will usually put it into excellent shape. Corn ground produces an earlier crop of rather shorter straw than the fallow and has given practically the same yield in many tests.

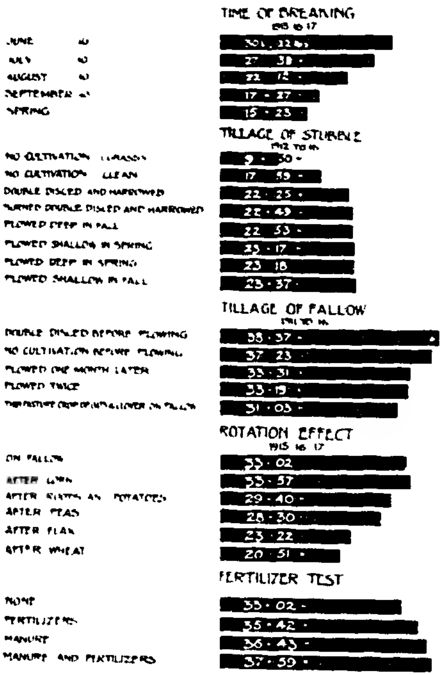

Fig. 42. The Culture of Wheat
Summary of Tests at Saskatoon

Fall plowing for wheat generally results in much lower yields than any of the three preparations already mentioned. In the drier parts it is not a popular practice, but in the more moist sections and in wet autumns it gives its best results. Fall plowing should generally be firmed down with a packer so as to lessen its tendency to dry out.

Spring plowing is seldom practised for wheat, since it necessarily makes the seeding rather too late for best results. In some seasons it is impossible to get the fall work done and spring plowing is then necessary. When it can be done early it is preferred by many even for wheat except in years when the soil is in a moist condition and plows well in the fall.

"Stubbling in" the wheat in unplowed land is a common practice in parts of central and western Saskatchewan and Southeastern Alberta for the second crop after a good fallow. Its advantage lies in its cheapness, its disadvantages in the more rapid spread of weeds and in lower yields if the land is weedy, grassy or the soil hard when sown. It is a less common practice in the more moist parts where its advantages are less and the disadvantages greater. It should never be practised on grassy or weedy land or on land that does not have a natural mulch or seed bed in the spring. In the drier areas, however, on clean land that is free from grass, and that does not "bake", stubbling in frequently gives better net results than plowing

Burning the stubble in the spring and then discing or sowing even without discing is a common practice in many areas. It, of course, dissipates organic matter and nitrogen both of which are lost in burning, but it gets rid of the stubble and often results in an immediate gain. On very rich soils where the stubble grows long it is a common practice, but one not to be encouraged on our poorer soils and not even on rich ones when a better system can be established. (See fig. 42).

The conclusions of the investigations of the United States Department of Agriculture as to the preparation

of land for wheat at fourteen stations in the plains areas south of the Prairie Provinces, while not applicable in their entirety to Western Canadian conditions are not without value to us. They are as follows:

(1) Some seasons are so unfavorable as to result in failure of the spring wheat crop without regard to the cultural methods under investigations. Extremely unfavorable climatic conditions can not be overcome by cultural methods.

(2) It is only in those seasons when the rainfall deficit is so small that it can be overcome by moisture stored in the soil that the cultural methods under investigation have shown important effects upon the yield of wheat.

(3) When the differences in value of the yields are less than the differences in cost of production, then cost becomes the determining factor.

(4) Some soils, even in the regions of profitable spring-wheat production, show little response to cultural methods.

(5) Reducing the cost of production has in most cases in these investigations proven a more important factor in determining profits than increasing yields by cultural methods.

(6) Disced corn ground has given consistently high yields. This together with the low cost of preparation, has resulted in its showing the highest average profit or lowest average loss of any of the methods tried at all of the fourteen stations except one. These profits are based on the assumption that the corn crop was so utilized as to pay for the cost of its production. (If the corn crop

was grown at a loss, this loss should be deducted from the profits on the wheat crop following it.)

(7) Subsoiling has been of doubtful utility as a means of increasing yields. As a means of overcoming drought it is without value.

(8) Summer tillage without crop has given the highest average yields of any method under trial at 12 of the fourteen stations. However, on account of its high cost, due to extra labor and alternate-year cropping, it has not been the most profitable practice with wheat.

104. Fertilizing Land for Wheat.—The maintenance of productiveness by the use of manures and fertilizers has not yet been given much consideration by the average western farmer. Cheap land, high priced labor and a fertile soil have each contributed to this condition. At the present time, however, in the older settled parts on land that has been cultivated for several years, and on soils that blow or are cold and produce late crops, as well as on those that are not naturally the most fertile, manure is coming to be regularly and systematically used.

Commercial fertilizers are seldom used. No tests of these have been reported where the increase in yield of wheat has been sufficient to pay for the fertilizer and cost of its application. Phosphatic fertilizers are probably the most beneficial, but even these have not yet been shown to be profitable. It is, however, only fair to say that but very few tests have been made and these generally on our best soils.

When manure is used for wheat on light land, best results are generally secured from plowing it under in the fallow season. On heavy land the same practice

may be followed, but with some risk from frost owing to later maturity and from lodging as a result of too rank growth in wet seasons. In the drier parts of the West manure is seldom plowed under in fall or spring before wheat, for the reason that it does not decay readily in the soil and may therefore result in drying out the surface. In the more humid parts this practice is more common, but oats or barley generally follow the manure. Where it is applied in this way only very light applications are used.

Manure gives its best results on light soils, particularly on those that blow and on very heavy soils such as the heavy clays, "burnt out" areas and alkaline spots. As a rule it is best to apply it to grass land or before a forage crop like corn or roots or potatoes, and then follow with wheat. Where none of these crops are grown the manure can profitably be utilized if it is applied thinly and well firmed down after plowing. On soils that are inclined to blow a thin surface dressing of manure after seeding often lessens soil drifting.

105. Preparing Wheat Seed for Planting.—The wheat seed used for planting should be taken either from a seed plot or from the best developed, least diseased and cleanest portions of the preceding crop. It should be (1) tested for percentage and vigor of germination, (2) cleaned thoroughly with a fanning mill to remove weed seeds, other kinds of grain, smut balls and immature or shrunken kernels, and (3) the cleaned sample should be treated thoroughly for disease. (See Sections 9 to 13 for discussion of seed treatment for disease.)

106. The Time to Sow Wheat.—Many factors influence the time that is best to sow wheat but chief among these

are the condition of the soil, and the average date of the first fall frost. At Saskatoon wheat was sown, both on fall plowing and the previous season's breaking, at five different times in the spring, each ten days apart, during each of the four years preceding 1918. On breaking the largest yield was secured from the April 20th seeding, while on fall plowing, April 30th gave the largest yield. In the rust season of 1916 the yield decreased very rapidly after the first seeding on April 20th. In these tests the soil was all well prepared the previous season and was in good tilth when sown. The data indicates that under central Saskatchewan conditions on seedings made after the first of May the yield and profit decreased rapidly. April 15th to 30th, on land that is in condition to sow, is regarded as the best time to sow wheat. (See Sec. 14).

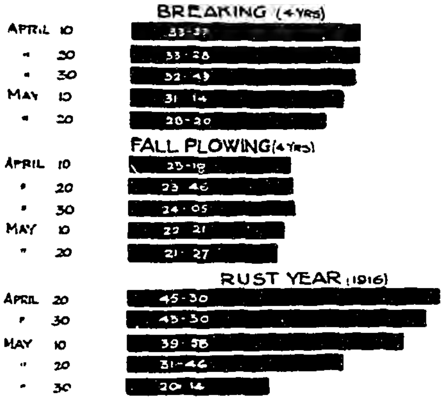

Fig. 43.—Dates of Seeding.
Chart showing average yields from wheat sown at different dates at Saskatoon

"Early seeding seems desirable (1) in all areas subject to early fall frosts, (2) on fallowed land, (3) on rich, productive and heavy soils, and (4) with all late maturing crops. Later seeding is permissible (1) in areas where fall frosts seldom do damage to the crops,

(2) on light, warm soils, (3) on fall or spring plowed or stubble fields containing little moisture and (4) with all early maturing varieties."

107. The Amount to Sow.—The results of the "rates of seeding" trials at Saskatoon, during a period of six years in each of which five different amounts were sown with a press drill on well prepared land, were in favor of the 1 bus. rate, although 2 bus. per acre gave the largest net yield in the three wet years 1911, 1915 and 1916 and the heavier seedings were all better in the 1911 season when the crop was frosted before maturing. The amount sown usually ranges between 45 lbs. and 2 bus., the commonest rates being 1 to 1½ bus. on the lighter soils and 1¼ to 1¾ bus. on the heavier ones.

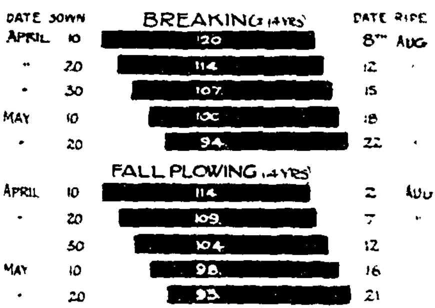

Fig. 44. Time of Seeding.
Chart showing the effect of time of seeding wheat on the time of ripening and the number of days maturing at Saskatoon.

"Relatively larger quantities should be used (1) on heavy soils, (2) on fields such as the fallow which contain a good store of moisture, (3) in all areas subject to early fall frosts, and (4) when the seeds are above the normal size, and, therefore, relatively few per bushel. If the percentage germination is low, heavier seeding should be practised.

Smaller quantities may be used (1) in dry areas, (2) on light soils, (3) on stubble fields which contain but a

limited supply of water, (4) where there is no danger of fall frosts, and (5) when the seeds are small in size but normally developed. Thinly seeded fields withstand the most drought, but thickly seeded ones mature somewhat earlier." (See Sec. 15.)

108. The Depth to Sow.—On land that is well prepared the best depth to sow wheat is the depth at which it will get the moisture and temperature conditions necessary for growth. This varies with the kind of soil, its firmness and moisture content, the time of seeding, the smoothness of the surface and the kind of drill used. As a rule wheat is sown from 1½ inches to 3 inches deep, but deeper seeding may occasionally be advisable. One should sow deeper on on a light soil than on a heavy one, deeper on a loose dry soil than on a firm wet one, deeper late in the season than early in the spring, deeper on uneven soil than on one having a uniform surface, deeper with a drill having no press

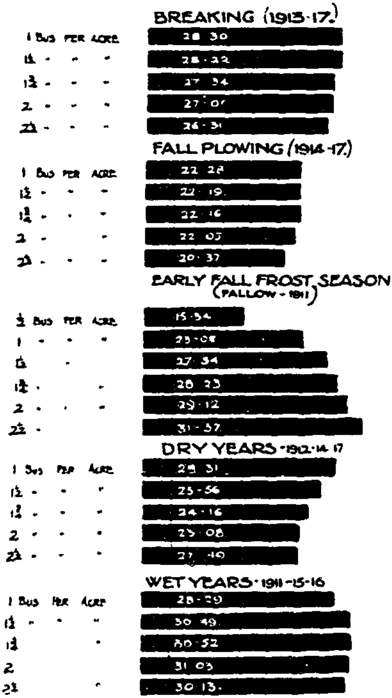

Fig. 45.—**Amounts of Seed.** Chart showing the effect of different amounts sown on the yield of wheat at Saskatoon

wheels than with one having this attachment, and deeper in dry regions than in humid ones.

The commonest error in the dry parts is too shallow seeding particularly on "stubble" fields. If sown too shallow to get moisture there is no hope of germination till rains come. On the other hand in the colder regions and on the heavier soils the man preparing the land should aim to have the soil moisture nearer the surface so that deep seeding into a cold soil may not be necessary. It sown too deeply there will be delay in germination and in extreme cases decay and death may result. There is, however, some consolation in the fact that after the plant is "up" it has the power within certain limits, of adapting its root system to the soil conditions. It remains for the crop grower to see that the seeds are given opportunity to germinate uniformly, quickly and vigorously. (See Fig. No. 7 and Sec. 16.)

109. The Time to Harvest Wheat.—The yield of wheat keeps increasing till the grain is mature but shattering increases with maturity. The color of the grain is best if the crop is cut shortly before perfect maturity. Some transfer of food material from stem to seed goes on even after cutting wheat on the green side. The danger of frost, the distribution of work, the advisability of early threshing all influence the time of cutting. As a rule one should try to cut most of the crop when in the "firm dough" stage. This often means starting earlier than this stage and finishing later.

110. Methods of Harvesting. Harvesting with the self-binder is the general method and probably the best, but it is very expensive. The header is not considered a suitable harvester owing to the frequent necessity of

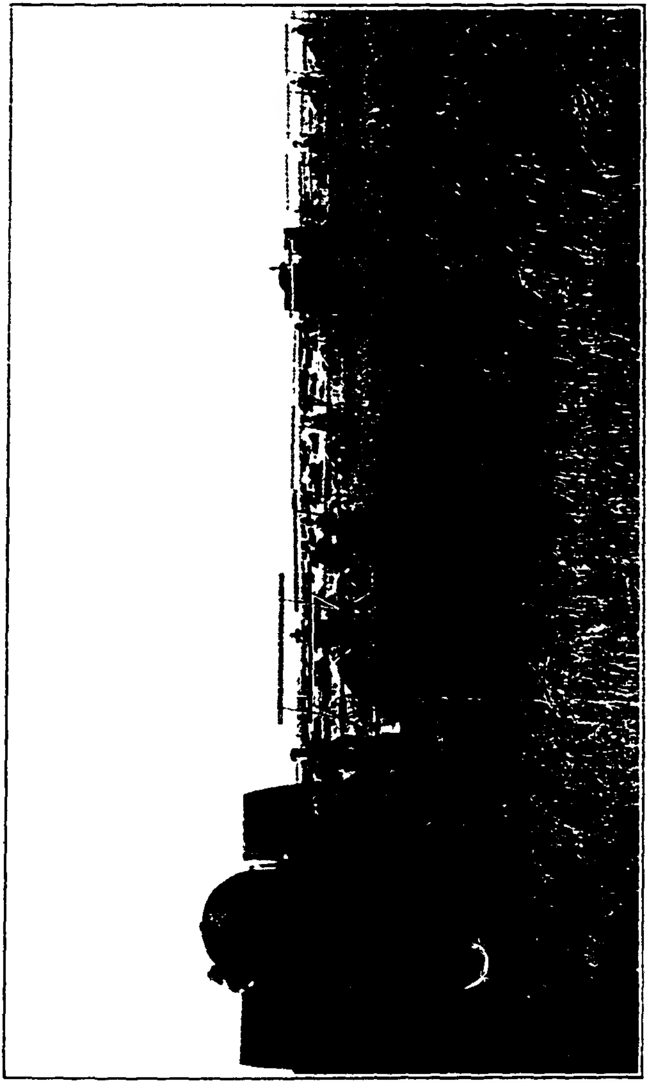

Fig. 16.—Harvesting Wheat by Motor Power.

cutting before the heads are dry enough to store. The combined harvester and thresher has not been thought suitable owing to the increased probability of danger from hail, wind, frost, shattering and lowered grade from weathering, as a result of the necessity of leaving the crop uncut till perfectly ripe and dry. There is need for investigating the relative advantages of different methods of harvesting. This operation costs us three times as much per acre as it does the Australian farmer who uses a stripper or modified header.

111. Curing Wheat. In this climate when the crop is harvested the straw contains too much moisture to be satisfactorily threshed and the seed contains too much to be safely stored. Under these conditions the sheaves must be cured before threshing. This is accomplished by stooking or by stooking followed by stacking.

112. The Objects of Stooking are:

1. To prevent injury to the grain from the moist soil.

2. To prevent excessive weathering of the grain in the head.

3. To permit the transfer of nourishment to the seed, and

4. To allow the straw and grain to dry out so that threshing can be satisfactorily done.

To achieve these objects the grain is put in long or round stooks. The latter are usually favored. For best results the stooks should be (1) firmly and carefully set up, (2) with the least possible exposure of heads and (3) they should be "capped" with sheaves in areas where the wind velocity is not too high to prevent them remaining in place.

113. Stacking. —*If stacking is practised it should be done as soon as the grain is well cured in the shock, usually after ten to fifteen days. Four stacks are commonly built, in pairs six to eight feet apart, to form a setting. The stacks are round and usually ten to twelve feet in diameter at the base.

In commencing the stack a large, round shock or stook, about eight feet or more in diameter is made; then two layers of bundles are placed one directly on top of the other, with heads resting against the shock, and the butts forming the circular base. The next layer is laid with the butts extending just past the bands of the outer row, like shingles, and so on, overlapping the rows a little more as the centre is approached; then another layer is added commencing at the outside.

Shocked bundles have a slanting butt. The successive outer layers are laid with the long edge of the butt on top and projecting beyond the layer beneath. The diameter of the stack is increased in this way until a height of seven or eight feet is reached. This forms the "bulge"..

From the bulge the stack should taper slowly to a point. This is done by laying the bundles with the short side of the slanting butt uppermost, gradually decreasing the diameter.

The middle of the stacks should always be kept high and well tramped—so high that the beginner will fear that the outside layers may slide off. Sometimes they will, but that is better than having rain-water soak in. The outer row need not be tramped at all. The loads should be pitched off from different sides of the stack

* Adapted from Farmers' Bulletin No. 678, by Ball and Clark

to encourage more even tramping and subsequent settling.

At the peak, which should be 20 to 24 feet from the ground, a sheaf should be securely fastened by driving a long stake through it into the top of the stack. Well built stacks will shed water perfectly.

114. Threshing Wheat.—When threshing can be done early, the most economical method is to thresh directly from the shock. The sooner it can be done after the grain is dry enough to store, and the straw dry enough to thresh satisfactorily, the better the results will be. If the grain is too dry it will crack badly in threshing.

115. Stook Threshing vs. Stack Threshing.—When dry, wheat will keep for an indefinite period. In the process of ripening it loses most of its moisture. When it is cut "on the green side", however, it carries considerable moisture and even when quite mature it often contains more than permits safe storage. Under these conditions the grain must be "cured", that is, permitted to lose its excess of moisture, otherwise it may "heat" or grade "tough" or "damp", or spoil in the bin.

To remove this risk, to facilitate threshing and to permit some further filling of the seed, "stooking" or both stooking and stacking are practised before threshing.

For the first few days after cutting, stooking is the most efficient way of "curing". If the stooks cannot be threshed shortly after they are dry, two difficulties face the grower, (1) the grain commences to suffer from weathering, and (2) tillage of the land is not practicable while the stooks remain in the field. To overcome these difficulties stacking is sometimes followed.

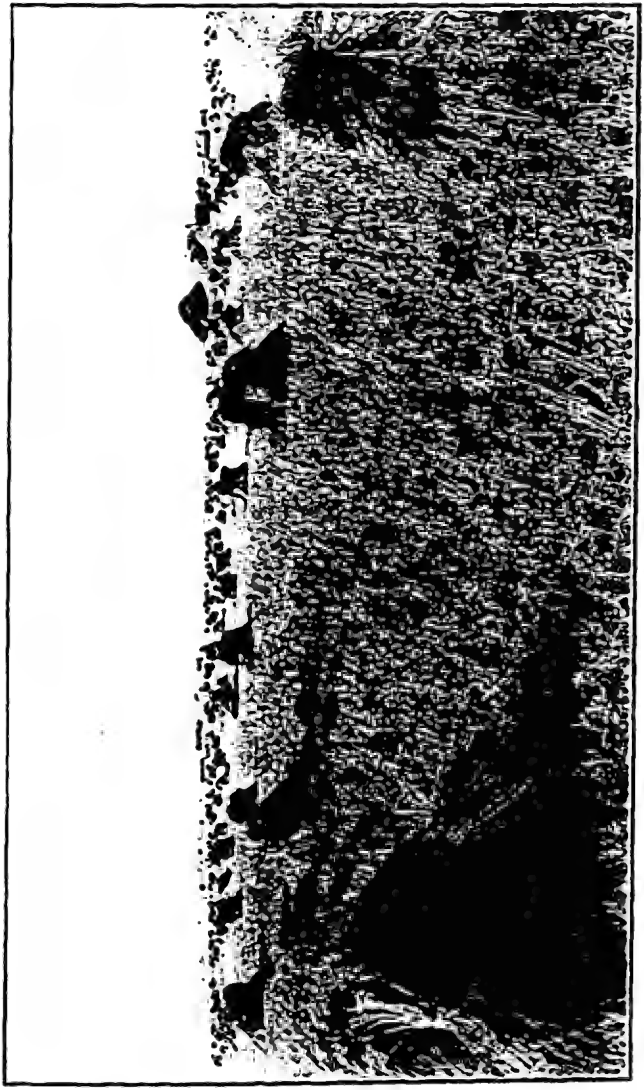

Fig. 47.—Stook Threshing.

Stacking prevents further deterioration from weathering, in fact, some improvement in quality usually results from it and it leaves the land unobstructed and free to be cultivated. It is a cheap form of storage and in areas where there are too few threshing machines to do all the work in good season it should be practised. To the small farmer whose acreage does not tempt the thresher to come to him early, it is a measure of safety.

The grower must determine for himself whether under his conditions the virtues of stacking more than offset the cost. Under many conditions they do. Under some conditions they do not. Where a man is sure he can get his threshing done early after harvest, it probably will not pay in normal seasons to stack. When he is not sure when the thresher will come, and particularly if his acreage is small and the season likely to be more or less wet, he would be wise to stack his grain.

Community threshing is desirable where the farms are not too large. The individual farmer will get his threshing done more rapidly and economically where a group of farmers own and operate a threshing outfit together.

The separator should be well cleaned before the threshing is started, in order to prevent the mixture of grain and scattering of weed seeds from the neighboring farms. The machine should be watched carefully to see that the chaff is all blown out from the grain and that no grain goes over into the straw.

116. Storing Wheat.—The grain may be stored (1) in movable granaries where threshed, (2) in stationary granaries at the buildings, (3) in the local country elevator, or (4) it may be shipped at once for sale or

for storage in an "Interior Storage Elevator" or in the terminals at Fort William or Port Arthur or elsewhere.

Ordinarily if the farmer is close to the shipping point the grain is drawn from the threshing machine either to the elevator or to a car to be loaded. If the farm is so far away that it is impracticable to get all or most of the grain hauled as it is threshed it is usually stored in portable granaries.

117. Storing in Country Elevators.—The country elevators, although owned and operated by private or co-operative companies, are, in so far as tariffs, grading and weighing is concerned, under the supervision of the Board of Grain Commissioners appointed by the Dominion Government for the purpose of administering the Canada Grain Act.

The "Rules and Regulations for Country Elevators" and "for Storing Grain in Country Elevators where there is a disagreement as to Grade and Dockage" together with "The Tariff of Licensed Country Elevator Charges for the year" are issued by the Board of Grain Commissioners and may be secured by writing the secretary at Fort William, Ontario.

118. Shipping Wheat.—Provision for controlling the distribution of cars is made in the Grain Act. Advice on such subjects as "How to get a Car for Shipping", "Rules for Loading Cars" and "Shipping the Car", is published from time to time by the Board for the information of shippers.

119. Storing in Terminal Elevators.—The "terminal" elevators in so far as their relation to the public is concerned are also under the control of the Board of Grain Commissioners. Information concerning the legal

tariffs and other matters pertaining to the handling of grain at these institutions may always be secured from the Board.

120. Grading Wheat.—The definition of the standard grades of spring and winter wheat as given in the Can-

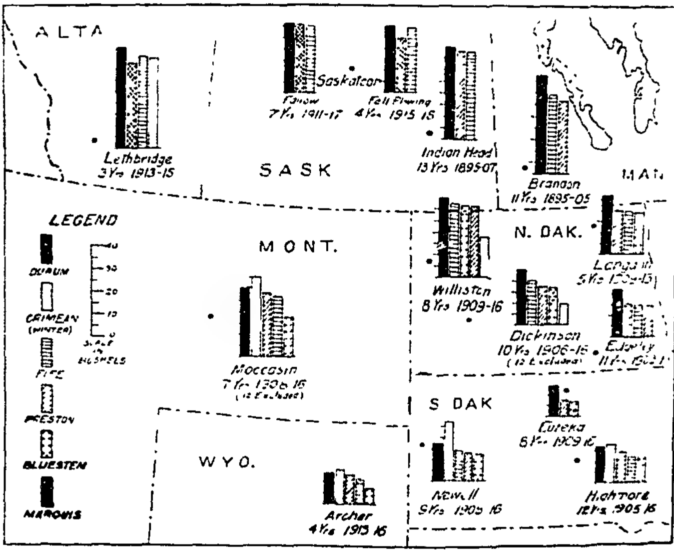

Fig. 48.—Relative Yields of Different Types of Wheat.
Different types of wheat in the Prairie Provinces and North-western States, United States data from U. S. D. A. Bulletin No. 618. The winter wheat used at Lethbridge was Minn. No. 561.

ada Grain Act, the regulations concerning grain other than the above grades, and the provision for establishing "commercial grades" are as follows:

"**Grades of Spring Wheat.**—No. 1 Manitoba hard wheat shall be sound and well cleaned, weighing not less than 60 pounds to the bushel, and shall be composed of at least seventy-five per cent. of hard Red Fife* wheat.

* Recently amended to include Marquis.

"No. 1 hard White Fife wheat shall be sound and well cleaned, weighing not less than 60 pounds to the bushel, and shall be composed of not less than sixty per cent. of hard White Fife wheat, and shall not contain more than twenty-five per cent. of soft wheat.

"No. 1 Manitoba Northern wheat shall be sound and well cleaned, weighing not less than 60 pounds to the bushel, and shall be composed of at least 60 per cent. of hard Red Fife* wheat.

"No. 2 Manitoba Northern wheat shall be sound and reasonably clean, of good milling qualities and fit for warehousing, weighing not less than 58 pounds to the bushel, and shall be composed of at least forty-five per cent. of hard Red Fife* wheat.

"Any wheat not good enough to be graded as No. 2 Manitoba Northern shall be graded No. 3 Manitoba Northern at the discretion of the inspector.

"No. 1 wheat rejected for smut and scoured shall be graded as scoured of the grade to which it belongs.

"No. 2 wheat rejected for smut and scoured shall be graded as scoured of the grade to which it belongs.

"No. 3 wheat and lower grades rejected for smut and scoured shall be graded as scoured of the grade to which it belongs: Provided that wheat which is inspected No. 3 Northern scoured, or lower, may be graded in such regular grade, not higher than No. 3, as the inspector determines.

"No. 1 wheat inspected as 'no grade' for moisture and dried shall be graded as dried of the grade to which it belongs.

"No. 2 wheat inspected as 'no grade' for moisture and dried shall be graded as dried of the grade to which it belongs: Provided that on the written order of the owner any No. 1 dried or No. 2 dried wheat may be graded as No. 3 Northern.

"No. 3 wheat and lower grades inspected as 'no grade' for moisture and dried shall be graded as dried of the grade to which it belongs: Provided that wheat which is inspected No. 3 Northern dried, or lower, may be graded in such regular grade, not higher than No. 3 Northern, as the inspector determines.

"**Grades of Winter Wheat.**—No. 1 Alberta red winter wheat shall be hard, pure red winter wheat, sound and clean, weighing not less than 60 pounds to the bushel.

"No. 2 Alberta red winter wheat shall be red winter wheat, sound and clean, weighing not less than 60 pounds to the bushel.

"No. 3 Alberta red winter wheat shall include hard red winter wheat not clean enough or sound enough to be graded No. 2, weighing not less than 56 pounds to the bushel.

"No. 1 Alberta mixed winter wheat shall be red and white winter wheat mixed, sound, plump and clean, weighing not less

than 61 pounds to the bushel, and containing not less than 50 per cent. red winter wheat.

"No. 2 Alberta mixed winter wheat shall be red and white winter wheat mixed, sound, plump, clean, weighing not less than 59 pounds to the bushel.

"**'No Grade', 'Condemned', 'Rejected' and Scoured Grain.—'No Grade'** grain.—All good grain that has an excess of moisture, being tough, damp or wet or otherwise unfit for warehousing, shall be entered on the inspecting officer's books as 'no grade', with his notation as to quality and condition.

'Condemned'.—All grain that is in a heating condition or is badly bin-burnt, whatsoever grade it might otherwise be, shall be reported and entered upon the inspecting officer's books as 'condemned', with the inspector's notations as to quality and condition.

"**'Rejected'.** All grain that is unsound, musty, dirty, smutty or sprouted, or that contains a large admixture of other kinds of grain, seeds or wild oats, or from any other cause is unfit to be classed under any of the recognized grades, shall be classed as 'rejected', with the inspector's notations as to quality and condition.

"**Scoured Grain.**—No grain that has been subject to scouring or treatment by the use of lime or sulphur shall be graded higher than No. 3.

"**Inspector's Reasons.**—All inspecting officers shall make their reasons for grading grain, when necessary, fully known by notations on their book.

"**Commercial Grades of Grain.**—If a considerable portion of the crop of wheat or any other grain for any one year in any division has any marked characteristics which exclude it, to the prejudice of the producer, from the grade to which it otherwise belongs, special grades may be established therefore in the manner hereinafter provided, and shall be called and known as commercial grades.

"**Selection of Commercial Grades.**—Should the climate or other conditions result in the production of a considerable proportion of grain, other than oats, not capable of being included in the classification provided for in this Act, the grain standards board for the division shall be convened for the selection of commercial grades and samples whenever the chairman of the said board is notified by the chief inspector or five members of the said board that such a course is necessary.

"**Use of Commercial Grades.**—Inspecting officers shall grade all classes of grain which cannot be graded according to this Act, in accordance with the commercial samples so selected by the board."

121. Controlling Insects and Gophers.—The common insects affecting wheat in the West are wire worms, cut worms, army worms, grasshoppers, sawflies, grain aphids and the Hessian fly. The habits and control of these is discussed in Chapter XIV. Other insects that occasionally attack wheat are the chinch bug, wheat midge, bulb worm and two different species of wheat straw worms. These have seldom been reported in the West.

The chief animal pest of growing crops is the gopher. The flicker tail gopher is the most common and does the greatest damage, but several other species may be found. Among these are the gray gopher or squirrel tail gopher, the striped gopher, the pocket gopher and the prairie dog, the last mentioned being seldom found.

The damage done by gophers, is of two kinds, the destruction of plants in growing crops and the nuisance created by the mounds thrown up from burrows in cultivated fields. The method of control usually followed is poisoning in early spring, although shooting, trapping, snaring, drowning and suffocating are sometimes practised.

There are many patent gopher poisons on the market, the active principle in each generally being strychnine. Grisdale in Experimental Farms Bulletin No. 31 gives a recipe for gopher poison that has been thoroughly tested and proven quite satisfactory. The recipe and also the time and method of distributing the poison is outlined by Prof. Grisdale as follows:

"Dissolve one ounce of strychnine or sulphate of strychnine in one quart of vinegar to which has been added one quart of hot water. Stir until all the strychnine is dissolved, boiling if necessary. Add one pound of sugar or one pint of molasses, and a teaspoonful of oil of anise. Pour the hot solution over half a bushel of wheat, and, if necessary, add enough hot water

just to cover all the wheat. Let the grain stand in the solution for 24 hours, and if any of the solution is then still unabsorbed, add a handful of shorts and stir the whole mixture well. Put a tablespoonful of the moist grain well into the entrance of each gopher hole.

"As strychnine is a deadly poison, great care should be taken with all utensils used, and while mixing and handling poisoned grain, so that accidental poisoning of farm animals, or children, may be prevented.

"The cost is not great. The four gallons prepared as indicated above should be enough to treat half a section of land and also to a distance of a quarter of a mile or more on the outside of the same. The ordinary retail price of strychnine sulphate is about $1 to $1.25 an ounce.

"The first application should be made as soon as the snow is off the ground in the early spring. The gophers are then hungry, other food is scarce, and their numbers are only about one-third of what they would be a few weeks later. If an effective application is made at this time there will be practically no more trouble during the season, except from those that come from outside.

"A good equipment consists of a pail of the poisoned grain suspended from the shoulder by means of a strap, and a desert spoon with a long handle. The operator walks from end to end of the farm each time covering a strip of not more than twenty-five yards on either side of the line he is following. In this way he is able to see every hole. He drops a spoonful of the poisoned grain well down each hole, thereby keeping it out of reach of prairie chickens, and at the same time causing gophers to die in their holes, where they are not a menace to anything else. After the farm has been thus covered it is usually well to distribute the poison on a strip at least 100 yards wide round the outside of the farm, in order to lessen the danger of inroads by gophers from adjacent land.

"The unfortunate point in the using of poisoned grain is that it kills many of our native birds, and it is needless to say that in distributing the poison care should be taken to prevent domestic animals getting enough to hurt them. The amount that would kill a gopher would not be enough to kill a domestic hen, but one scarcely cares to take chances. This risk can be minimized by placing the poisoned bait, as indicated above, as far down the entrance to the holes as possible with the long-handled spoon mentioned."

123. Plant Diseases Affecting Wheat.—The most common diseases affecting wheat are the covered and loose smuts which, it has been estimated, cause an annual loss

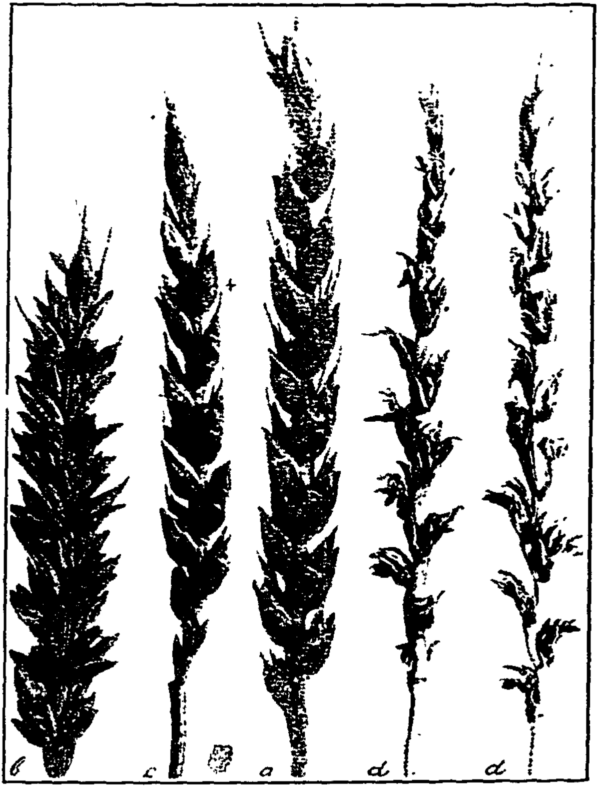

Fig. 49.—The Smuts of Wheat.

(a) a sound ear, lower half with hulls removed showing the sound grains in place; (b) characteristic "spread out" appearance of wheat ear infected with stinking smut; note the four smut balls showing where sound grains should have been formed; (c) ear partly affected with stinking smut; the cross indicates a perfectly sound wheat grain. Below this all grains are more or less completely infected with smut. (d d.) Two ears of wheat destroyed by loose smut, no grains are formed. Picked at the time of flowering. By courtesy R. T. Gussow

to the farmers of Canada of over $16,000,000. A less common disease but one that in 1916 caused a loss of between $50,000,000 and $100,000,000 in Western Can-

ada alone is the Black or Stem Rust. This disease is of frequent occurrence in the Red River Valley but does little damage further west except in moist warm seasons such as 1916. Other diseases of minor importance in the west are the orange leaf rust, the yellow or stripe rust, wheat scab, glume-spot and anthracnose.

123. Bunt, Covered or Stinking Smut.—This disease is due to a microscopic fungous plant which lives inside the tissues of the wheat plant, and which monopolizes the nourishment intended for the wheat seed, producing instead of the kernels, an equal number of smut balls each containing two or three million ill smelling spores or seeds of the disease. These smut balls are generally broken in the threshing process and the small spores become widely distributed among the wheat seeds, clinging to the hairs at the end of the kernel as in "tagged" grain or sheltering themselves in the crease of the seed. When the infected seed is planted and commences growth, these spores germinate and eventually send out a fine hair-like growth which penetrates the tissues of the young wheat seedling, usually between the time of germination and the appearance of the green leaf above ground. Subsequently the fungous lives a parasitic existence inside the wheat plant, subsisting on the nourishment that should go to developing the wheat, and producing at harvest time the smut balls mentioned.

The infected plants can be distinguished in the field by their darker green color, shorter, more upright and more stunted growth, and as ripening approaches the heads have a broader appearance due to the plumpness of the smut balls which later become visible through the spreading apart of the chaff. (Fig. 49).

Bunt or Stinking smut can be controlled (1) by removing the unbroken smut balls with the fanning mill or floating them off in the treating process, (2) by killing the spores that have found lodgment on the grain with formalin, bluestone solution or hot water and (3) preventing reinfection through contact with spore infected bags, wagon boxes or drills. The method of control is outlined in Sec's. 9 to 13.

124. Loose Smut of Wheat.—This also is a fungous disease but one having a life history quite different from the covered smut. Shortly after the wheat plants head out some spikes will appear having masses of loose black powdery dust where the spikelets ordinarily should be. These black masses consist of millions of spores, which become detached from the stem of the head and blow about freely with the wind. Some of these spores find their way into the blossoms of many of the later plants, where they germinate, the mycelium penetrating the tissues and living within the developing seeds. They do not take complete possession of the seed the year the infection occurs, but remain inside the tissues in a more or less dormant state. When this seed is sown and the plant grows, the mycelium of the fungous grows also and eventually monopolize the heads, producing, shortly after heading, the loose masses of black spores referred to before. These blow around and reinfect other blossoms, as in the previous season, and the reproduction of the species is thus provided for. The life history of this disease is well illustrated in Fig. 50.

Since the disease is not on the outside of the seed, as in stinking smut, but inside the tissues, no outside treatment, such as with formalin or bluestone, will control it.

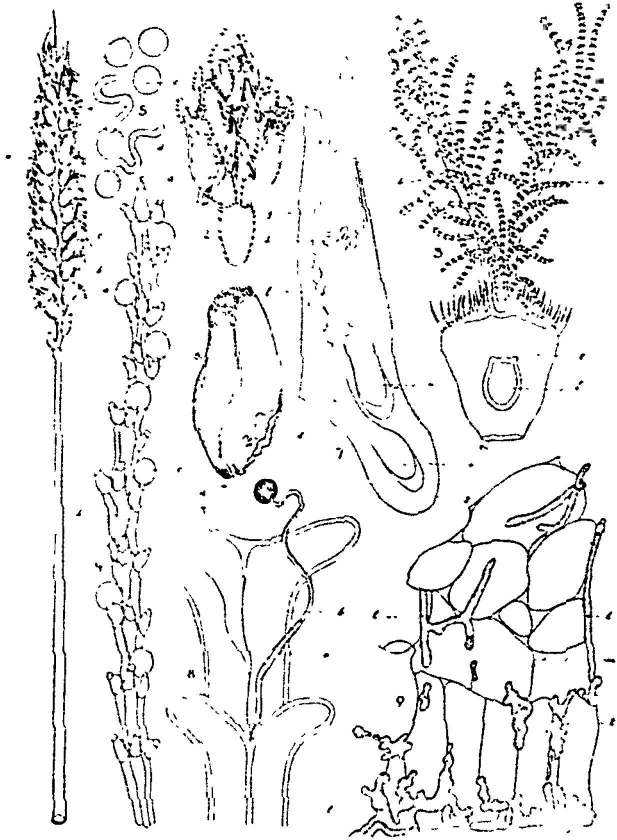

Fig. 50. Showing Infection of Wheat by Loose Smut.

Diagrammatic representation of mode of infection of wheat by loose smut 1 An ear of wheat in flower, (a) anthers. 2. Single Spikelet of wheat ear; (a) anthers 3 Female organs of flower, (b) the feathery style. (e) ovary. (f) ovule 4 Part of style (b). covered with pollen grains (c) 5 Pollen grains (c), showing germination tube (d) 6 Section of wheat grain showing the young plant (h) 7. The young plant removed from the wheat grain, much enlarged; (g) the "scutellum or disc through which the young plant absorbs its food from the body of the grain, (h), the growing point, (i), the primary root; (j), its sheath. (k) secondary root, (l). black lines showing position of mycelium of loose smut fungus as found in the grain. 8 Part of the style (b) showing a loose smut spore (n) pushing mycelial tube (o) into the tissues 9 Microscopical preparation showing mycelial masses of fungus within the tissues of the grain (m) By courtesy H T. Gussow

It has been found, however, that the disease can be killed by the hot water treatment, first devised by Jensen, of Denmark, and later improved by different men. This treatment, though somewhat difficult and complicated, results in the destruction of the disease, with only slight injury to the seed. It lessens the germination of strong seeds and kills many of the weaker ones, but it is the only method known for effectually controlling the disease after infection takes place. The hot water treatment is outlined in Sec. 13, and further discussed in Sec. 172.

The best preventive measure for loose smut is to operate a seed plot and remove, by hand-picking, the diseased plants as soon as the heads appear and before the spores start to blow around. If a small quantity of seed is treated with hot water, as outlined in Sec. 13, and sown at some distance from the main fields of wheat, and rogued regularly every day or two for a time after heading, the disease can be eradicated. If this is done it will not be necessary to treat with hot water again unless spores carried by wind from surrounding fields make it advisable. As a rule it is not advisable to treat all of the seed sown. It is generally preferable to treat a small quantity and use this to produce seed for subsequent growing.

125. The Life Story of Black Stem Rust.—*"Rust is a parasite which lives on wheat, oats and other grains, and on grasses, from which it steals its food. When the rust attacks the grain plant, it causes a serious disease which injures the plant, reducing or totally destroying the yield. Rusted plants produce light-weight, shrivelled grains, and at harvest time the straw is marked with numerous black stripes and is often crinkled and broken.

"The rust parasite is a fungous plant of microscopic size and is made up of very small, much branched, thread-like strands

* Reproduced as written and illustrated by Mr. E. M. Freeman, Division of Pathology, University of Minnesota.

which grow inside the leaves and stems of the grain plant. The parasite spreads from one wheat plant to another by means of very small bodies called spores, which act somewhat as do the seeds of other plants. The rust parasite has several kinds of spores, and each kind is especially adapted to its particular use and season. In the summer the rust produces on the wheat and other grains the red or summer spores. These are egg shaped and orange red in color. They are formed in stripe-shaped pustules just under the "skin" of the leaf or stem, which is broken open to release the spores into the air. These red summer spores are formed in great numbers and are so numerous that they form clouds of red dust when the binder goes through the field. They are so small and so light in weight that they are easily taken up by the wind and carried to neighboring plants, or they may be carried many miles to start the disease in a new place. When a summer spore falls on another wheat plant and when it becomes moistened by a drop of dew or rain, it sends out a little thread which grows into the wheat plant and starts another infection, and thus more rust. When the season is favorable, the summer spores spread the disease so rapidly and so widely that a general epidemic with a tremendous loss in yield results.

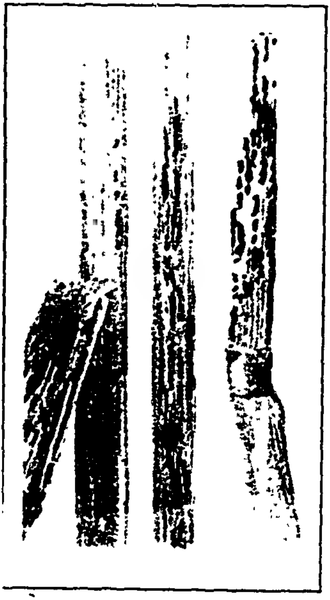

Fig 51. Black Rust on Stem and Leaf of Wheat.

"At about harvest time a new kind of spore is produced, viz., the black or winter spore. This spore is also formed in stripe-shaped pustules, but in this case the pustules are black and are found mostly on the stem or head. These black pustules, or stripes, are very conspicuous and are formed when the damage from the disease becomes most evident and hence the farmer speaks of the rust as the 'black rust'. The black stripes of winter spores remain in the straw and stubble over winter and do not develop until late in the spring, viz., in April or May. The winter spore is not generally carried by the wind, but

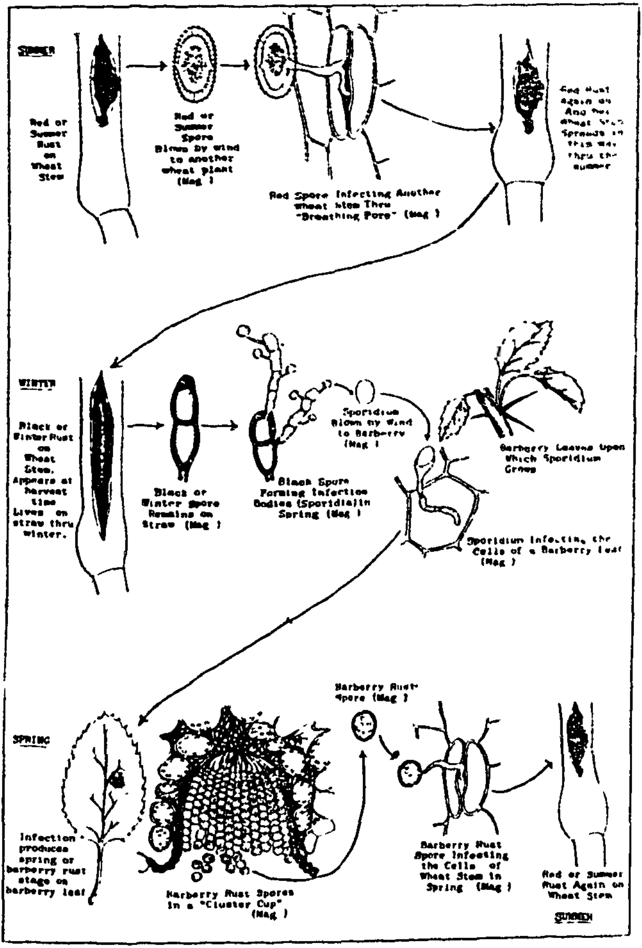

Fig. 52.—Life Story of Black Stem Rust.

Diagrammatic representation of life story of black stem rust of wheat (as seen through the microscope). Follow the arrows.—By courtesy E. M. Freeman.

germinates on the straw where it was formed. When it germinates, it sends up one thread from each of its two compartments, and on each of these threads it usually forms four very small, round, colorless spores (sporidia). These tiny sporidia are now blown about by the wind and may again propagate the disease, but they are not able to infect another wheat or oat or grass plant. They can only continue to develop the disease if they fall on a totally different plant, viz., the common barberry, which is an ornamental shrub grown in lawns and gardens and often used for hedges.

"On the leaf or fruit of the barberry the sporidia from the winter spore may start another infection and from this infection there is produced from early in May until midsummer, or, sometimes late summer, still another kind of spore called the cluster cup spore. It gets this name from the fact that on the yellow and swollen spots on the barberry leaf, clusters of small, orange colored cups are formed, and in each cup a large number of reddish spores are produced in long chains. These spores are also picked up by the wind and again the disease is spread, but here again the spores can not infect the same kind of plant on which they were formed, that is, they can not infect another barberry plant. If, however, they fall on another wheat plant under favorable conditions, they will infect the wheat plant and from this infection the summer spores are once more produced. The summer spores then continue to spread the infection as described.

"The life story may be briefly summarized as follows: (1) The red or summer spores spread the disease from wheat to wheat or from wheat to grasses and back to wheat. (2) The winter spores formed on wheat or grasses at harvest-time remain on the straw until spring, when by means of sporidia the infection of the common barberry takes place. (3) The cluster cups, or spring spores, on the barberry start the infection again on the wheat or grasses.

"Many people think the rust is caused by weather, especially wet weather. They are only partly right. The real cause of the rust is a parasite, but the weather greatly affects the development of the parasite. In some years the weather is favorable to the development of the rust and then epidemics occur. One must keep in mind, however, that the weather may be favorable at one stage, for instance, the barberry stage in May and June, but not favorable for the development of the summer and winter stages in July and August. If the weather is favorable for all of them, a heavy epidemic occurs. The most favorable weather for the development of the summer stage is that in which cool nights with heavy dews alternate with warm, muggy days. Heavy dews furnish excellent moisture conditions, but heavy rains wash a great many of the spores down into the

ground. Very hot, dry weather is unfavorable to the rust. Cool weather or any other condition which delays the ripening of the grain gives the rust more time for development.

"Black stem rust of grains also lives on certain wild and cultivated grasses, and, in the summer spore stage, can pass freely from the wheat to these grasses and back again to wheat. The wheat rust goes especially to wild barley (squirrel-tail grass), western wheat grass, and many other grasses. In fact, practically all of our wild and cultivated grasses are attacked by some grain rusts. It would be a great help in fighting rust if such a weed grass as wild barley could be completely eliminated, but, of course, this is not practicable. It is very clear, however, that clean farming—i.e., clean cultivation and keeping down weeds and grasses in fence-corners and old pastures and roadsides—will help to reduce the chances for rust, and if every farmer would keep his farm as clean as possible from these weed grasses it would undoubtedly help in the control of rust."

126. Control of Black Stem Rust.—Black stem rust cannot be controlled once it appears. Preventive methods are the most promising with this disease. The destruction of the barberry in all wheat-growing areas is the best preventive practice. The following summary of observations made in the rust year of 1916 indicate the three chief measures that result in lessened damage from this disease. These are:

1st. To destroy other hosts of the disease.

2nd. To have an early crop, and

3rd. To use rust resistant varieties.

Where barberry is found the disease is fostered and its virulence greatly increased. (The same applies to the Buckthorns, which serve as a secondary host for the crown rust of oats). These are of importance only as ornamental shrubs, and, moreover, have plenty of good substitutes.

Steps should be taken to prevent the introduction of these plants, and those that are already present should be destroyed. Many of our common grasses, both wild and cultivated, are attacked just as severely as the cereal

crops by the various cereal rusts, and from these plants it is known that the cereals can become infected. The burning of infected wild grasses should be encouraged, not only as a practice of clean farming, but also to lessen the ravages of rust.

The chief practices that result in earlier crops, and consequently in increased yields in rust seasons, are early seeding, the use of early varieties and early classes of crops, somewhat thicker seeding, the packing of loose soils, the use of loam or warm soil in preference to heavier, colder or darker types, the use of well-balanced (if any) rather than nitrogenous fertilizers, a larger proportion of the crop on "breaking" and well-prepared fall or spring plowing and a smaller proportion on fallow.

The use of rust-resistant varieties is a most promising preventive measure, but unfortunately the only wheats that are known to be rust-resistant are types not ordinarily grown in this country for bread-making purposes. The Durum, or Macaroni, wheats have proven the most resistant under our conditions, but some others have recently been found that are also rust resistant. It is hoped that by crossing, this desirable character may be transferred to our otherwise good varieties without the latter losing any of their desirable qualities.

127. Rusts in General.—The Orange or Brown Leaf-rust occurs on wheat, barley and rye, as well as on several of the "hay" grasses. It is the most widely distributed of grain rusts and is the earliest to appear on wheat. The early spores are, in this country, orange in color. This disease is frequently present in western grain, but seldom does serious harm.

Yellow or Stripe rust affects wheat, barley and rye. This rust occurs quite early in the season, but appears to be less widely spread than either the Orange or Black rust.

128. Wheat Scab.—This is a fungous disease which attacks the glumes or chaff of the wheat head, causing dead sections, which appear conspicuous in a green crop. It is usually characterized by a pink coloring at the base of the dead glumes and about the stem of the head. This disease usually does little damage, but occasionally it seriously lessens the yield. Burning the stubble has been recommended where it has been serious.

129. Anthracnose.—This disease may be found on wheat, oats, rye or different grasses. It attacks the heads and roots and basal portions of the plants, usually doing most damage to rye. When the head becomes diseased the portions above the point of attack die. When the lower part of the plant is affected it turns dark in color, and eventually dies, resulting in the shrivelling of the seed. The formalin treatment aids in its control, but is not considered a total preventive, as there are probably other sources of infection besides the seed.

CHAPTER V

OATS

The Cereal of the Park Belt.

130. Oats in Western Canada.—In Western Canada oats is the queen of stock foods, surpassing all others in most parts in yield of grain and cheapness of fodder and excelling them in feeding value both as a concentrate and as roughage.

The chief uses of the oat crop are (1) a concentrate for horses and other stock, (2) a hay crop for all classes of stock, (3) an ensilage crop and (4) as human food.

Oats constitutes practically the only concentrate fed to horses in the West. It can be easily and cheaply grown and is well suited to the requirements of working animals. It is also the chief forage now used for all classes of stock in the grain growing areas, where it is sown usually on spring plowing after the wheat is seeded, and harvested with the binder when in the milk or early dough stage. It is now being satisfactorily used as a silage crop in the more moist districts that are not well suited to growing corn. For this purpose it is frequently sown in a mixture with peas. Oats are also used by a large percentage of the population as a breakfast food in the form of rolled oats. In this form

it provides more nourishment at lower cost than any other cereal.

Its relative importance is greatest in the park belt just north of the wheat regions, in the higher altitudes of the third prairie steppe and on some of the heavier types of soil in the wheat regions where wheat is subject to lodging or to fall frosts. It is grown more or less in all districts, but less in the eastern Chinook belt and in the more favored wheat regions than elsewhere.

In Manitoba oats occupy over one-third of the grain acreage, in Saskatchewan about one-quarter and in Alberta nearly one-half. Manitoba now produces

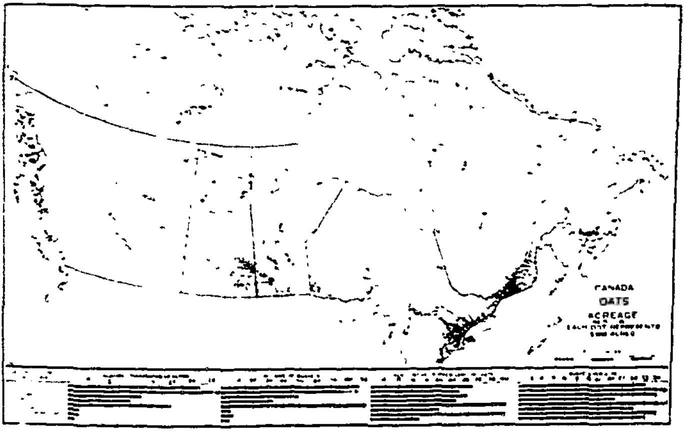

Fig. 53.—Distribution of Oat Acreage in Canada.
By courtesy Finch & Baker. Statistics revised.

about one-seventh of the Canadian crop, Saskatchewan over a third and Alberta between one-quarter and one-fifth, while British Columbia produces less than one per cent. of it. The three Prairie Provinces now produce about two-thirds of the total Canadian crop.

131. Oats in Eastern Canada.—Ontario produces nearly one-quarter of the Canadian crop, Quebec about a tenth, New Brunswick and Prince Edward Island about two per cent. each and Nova Scotia less than one per cent. In Ontario and Quebec oats are grown chiefly for feeding to beef and dairy cattle.

132. Oats in the United States.—*"The oat crop ranks third in acreage and fifth in value in the United States, while in number of bushels it exceeds all other crops except corn. . . . . .

"Although oats are a relatively unimportant crop in three-fourths of the United States, occupying less than one tenth of the improved land, the oat is, nevertheless, the most widely distributed agricultural plant of the country except the potato. This wide distribution is due in large measure to the local use of oats for horse feed. Oats are too bulky to bear the cost of long-distance transportation, and, moreover, no other feed seems to give horses quite so much spirit and energy as does oats, hence they are grown on many farms at a cost which would often involve financial loss if the crop were sold at market prices.

"In the great oat-producing region of the central United States this crop is particularly important, not only because the grain is desired for feeding work animals, but also because it offers a spring grain needed in the crop rotation with corn, spring wheat not being adapted to this region. Wherever hay is grown in the rotation, the oats also serve as a nurse crop for clover or timothy."

* Sections 132 to 134 from "Geography of the World's Agriculture," by Finch and Baker.

133. Oats in Europe.—"Russia is the largest producer of oats in Europe. The region of heavy production is coincident with the rye belt. The oats, however, are spring sown. Their position north of the spring wheat belt indicates their preference for a moister, cooler climate. The hardiness of the crop and the short time required to mature it are shown by the appreciable acreage extending nearly to the Arctic Circle in Finland and Sweden. The importance of oats on the narrow, sandy strip on the German Baltic coast and in Denmark is noteworthy as evidence of the ability of this crop to give profitable returns on poor soil. In France the oat

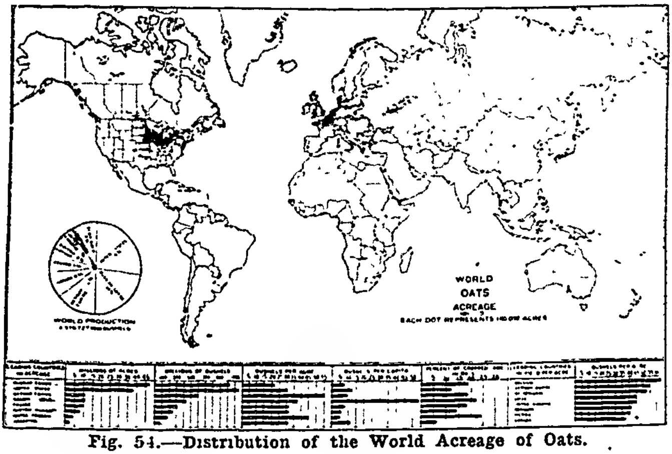

Fig. 54.—Distribution of the World Acreage of Oats.
By courtesy Finch & Baker. Canadian Statistics revised.

region is coincident with the more humid portions of the wheat belt, where the crop alternates with wheat in the rotation.

"The proportion of cropped land occupied by oats exceeds 20 per cent. only in the United Kingdom and Sweden. In these regions of cool, moist climate, oats are

a very important crop. In Scotland, particularly this grain furnishes an important element of the human diet. . . . Oat straw with turnips furnishes the chief winter ration for cattle.

"Like rye, oats enters but little into the foreign commerce of European countries . . . hence it is not so necessary that they be produced near the shipping centres. The principal regions where consumption exceeds production are the northwestern countries which have large animal industries, with the United Kingdom in the lead. These countries import about 10 per cent. of their supply of oats. An important demand comes also from the countries of southwestern Europe, which import about 5 per cent. of their supply. The countries of eastern Europe produce the bulk of the exports. Only about 1 per cent. of the European supply comes from other continents."

134. Soil and Climatic Conditions Desired.—"Oats grow best in cool, moist climates, such as are found in most of the northern European countries, in the northeastern United States, and in Canada. The plant has large, pendent outer glumes, and is peculiarly adapted to withstand rain during the flowering period. Oats are not usually profitable in regions of high temperature unless abundant water is available. In California, in Mediterranean countries, and in Australia, however, oats are sown in the autumn, utilize the winter rainfall, and are cut just before maturity for hay. In regions of mild winters, such as the southern United States and southwestern France, oats are also sown in the autumn for grain. On the southern border of the oat belt yields are not usually as high as in the north, because climatic conditions are less favorable for the growth of the crop.

Oats are grown on a wide variety of soils and yield well on rather poor soil, provided it is moist. The world distribution of the crop is little influenced by the soil factor."

135. The History of Oats.—The time and place of the origin of oats have not been well established. One species of oats (*Avena sterilis*) had its origin in the Mediterranean region of northern Africa, but the commonly grown species (*Avena sativa*) is thought to have originated in the more temperate climate of eastern Europe or western Asia. Most of our best Canadian oats have reached us through northern Europe, although the best early sorts have come mostly from southeastern Europe, while the little used but interesting hulless oats have come chiefly from China.

136. Oats as a Feed.—*"The oat grain is higher in crude protein than is corn, and in fat it exceeds wheat and nearly equals corn. Oats are the safest of all feeds for the horse, for the hull gives them so much volume that the animal rarely suffers from gorging. For dairy cows there is no better grain than oats. Oats mixed with other concentrates are helpful in starting fattening cattle or sheep on feed. As fattening progresses more concentrated feeds should be substituted for all or most of the oats. Ground oats with the hulls sifted out provide a nourishing and wholesome feed for young calves and pigs. For breeding swine whole oats in limited quantity are always in place."

137. Qualities Desired in Oats.—The power to produce large yields is the chief quality desired in oats. Yield is

* From "Feeds and Feeding", sixteenth edition, by Henry and Morrison.

a measure of all other essential characteristics, but when information on the relative yield of different sorts for any particular soil or climatic zone is lacking, knowledge of the characteristics of different varieties enables one to choose more intelligently the kind he should use.

In addition to high yield we desire in western oats, high quality, earliness, disease resistance if possible, stiff straw and little tendency to shatter. By high quality is meant a high proportion of kernel to total weight. This percentage may range from 55 to 80 but is generally between 65 and 75. The hull is of but little more value than straw. A sample containing 75 per cent. of its weight in the form of kernel is worth 15 per cent. more than a sample containing only 65 per cent. of kernel. A stiff straw is desired, particularly for heavy soils and fallowed land. Non-shattering tendency is desirable in order that the loss in harvesting and handling may be small.

Very little information on disease resistance is available, and not much more on stiffness of straw and tendency to shatter, except in so far as the average yield expresses these qualities. The tables (Figs. 55 and 56) give specific information on some of these points and the next two paragraphs discuss the chief characteristics of the varieties in some detail.

138. Types of Oats.—There are three main classes or types of oats in each of which varieties of different color may be found. One class is characterized by an open head, i.e., one in which the branches of the head come out nearly at right angles to the rachis or central stem. This class has a short, fine straw and small, long, rather slim kernels of good quality, having 74 to 77 per cent. of

kernel. Oats of this group are low yielders, 55 to 60 bushels per acre on the average, but mature early—90 to 100 days—and hence escape fall frosts and severe damage from rust. Daubeney, Sixty Day, Kherson, O. A. C. No. 3, Yellow Russian and Orloff are varieties of this type.

Another class, known as the Banner or "dual purpose" type, possesses panicles which may be described as slightly compressed, in which the branches generally lie more closely to the rachis. The straw is of medium quality, fairly strong and medium to long. The grain is plump, medium to long, and is good in quality having 71 to 74 per cent. of kernel. This class is medium to late requiring 100 to 110 days to mature but it includes our heaviest yielders. Most of the varieties now grown in the West belong to this group. Banner, Victory and Gold Rain are the best producers of this type.

The third group is known by the name "Side" oat or "Mane" oat. This group possesses closely compressed heads, or closed panicles. The straw is rather long, heavy and coarse. The grain is very short and plump. The quality of the grain, however, is low, the seeds having a low per cent. of kernel—50 to 72 per cent. They are late in maturing, more likely to be severely damaged by rust and are lower yielders than the Banner type. Fifty-pound Black, Dodd's White, Gold Queen and Black Tartarian are typical varieties of this class.

139. Varieties of Oats.—The Dominion Cerealist, basing his recommendations on tests made at the different Dominion Experimental Farms, advises as follows, concerning oat varieties:

Fig. 55.—*Table showing average yield, percentage of kernel to total weight, days maturing and number of kernels per lb. in representative varieties of different types of oats at Saskatoon:*

	Yield per acre 3 yrs.		Percentage of kernel to total weight, 3 years	Days maturing, 3 years	No. of kernels per lb., 2 yrs.
Early Type—	bus.	lbs.			
Daubeney	66	5	71.21	97	21,922
Sixty Day	60	[illegible]	73.19	98	...
Banner Type—					
Banner	80	33	70.80	110	18,373
Victory	80	17	70.39	111	17,214
Gold Rain	77	11	72.63	108	18,766
Side Oats Type—					
50 lb. Black	50	7	67.70	...	13,314
Garton's No. 22	65	26	...	110	14,182

Banner and Ligowo are among the best. Ligowo is slightly earlier than Banner but does not usually produce quite so large a crop. Victory is a new and promising sort. Daubeney may be used if it is essential to have a very early ripening variety. The commercial sorts—Orloff and Sixty Day—are still earlier but they yield less. Liberty, a fairly productive hulless sort is suggested for the production of feed for young pigs and chickens and for oatmeal for human consumption.

The University of Saskatchewan recommends Banner, Victory and Gold Rain for most parts of Saskatchewan.

140. Characteristics of Leading Varieties.—

Banner is a heavy yielding variety having a fine but strong straw, and a slightly compressed panicle or head. It is a late oat. The grain is white, rather long, medium plump and posesses a high per cent of kernel.

Fig. 56.– Table showing five year average yield of different varieties of oats at different stations—figures for each station are comparable but are not necessarily so between different stations.

	Brandon	Indian Head	Saskatoon, 1911-17 incl	Scott, 1912-15 incl	Rosthern	Lethbridge, 1912-15 incl	Lacombe
	bus lbs	bus lbs	bus lbs	bus lbs	bus lbs	bus lbs	bus lbs
Banner	102 17	123-30	77 06	90 28	105-16	102-20	102-00
Victory	98 00	129 31	71-02	....	106-22	104-19	110 22
Gold Rain	102 17	102-13	73-22	....	....	96-28	....
Ligowo	100 09	116-31	68-13	93-16	96-09	82-07	....
Irish Victor....	....	....	....	....	....	....	108-18
Abundance Reg.	92-29	....	69-01	....	103-22	....	97-30
20th Century ..	101-17	111-16	....	91-02	101-14	....	....
Swedish Select.	97-10	120-20	....	....	....	....	93-00
Daubeney	99 03	....	60-08	72-07	82 28	72-11	....
Tartar King ..	....	....	....	86 04	....	101-09	94-01

Victory is a heavy yielder and has a stiff straw of medium height with a rather short, slightly compressed type of panicle. It also is a late variety. The grain is white, plump, shorter than Banner and usually weighs more per measured bushel.

Gold Rain is also a heavy yielder, has a strong straw, shows slightly more quality than most other sorts and is two or three days earlier than Banner or Victory. The kernels are yellow in color and this for a time was considered an objection. However, the miller does not object to it and it grades as white oats in spite of its color so that no one need hesitate to use it on this account.

Daubeney is a white oat of high quality, earlier than those mentioned above, but less productive. Kherson, Sixty Day and Orloff are rather earlier than Daubeney, equally good in quality but less productive.

141. Wild Oats and False Wild Oats.—One of the worst features of oat production is the difficulty experienced in getting seed that is free from weed seeds and in keeping it so. The most objectionable weeds are wild oats, the seeds of which cannot be entirely removed from oats by cleaning or grading with the result that many are

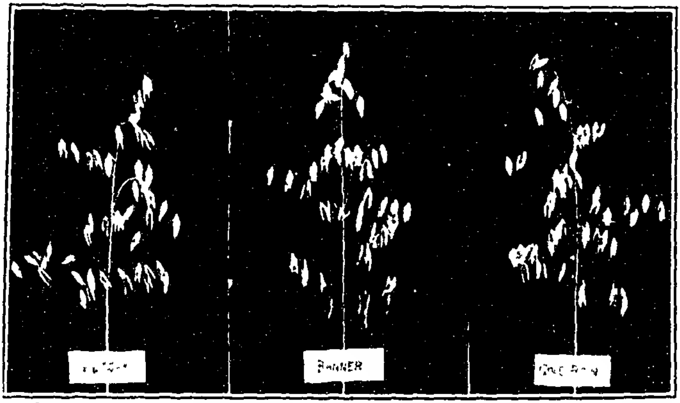

Fig 57—Three of the Leading Varieties of Oats in Western Canada.

sown every year. Wild oats are objectionable for two reasons—they are low in yield and in percentage of kernel, and the greater part of the grain is lost by shattering. It falls on the ground only to volunteer as weeds in subsequent seasons. As pasture or hay wild oats is of practically the same value as tame oats. The plants vary widely in growth characteristics as well as in size, color and hairiness of the seeds.

A type of oats having some of the characters of the wild and some of the tame oats is frequently found in the seed. This is called false wild oats. It generally resembles the variety in which it is found except in that

(1) on the base of the seed there is a "horse shoe" or "sucker mouth" attachment. (2) there are usually a few hairs arising from the base. (3) each seed of the spikelet

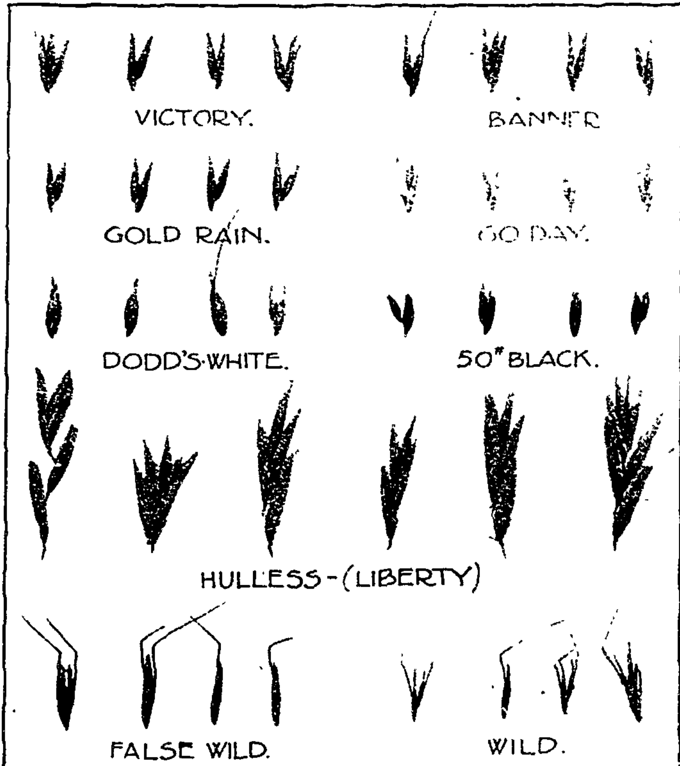

Fig. 58.—Seed Types of Different Varieties of Oats.
Wild and false wild oats are included; also spikelet of the hulless oat Liberty

bears an awn which is twisted and bent nearly at right angles, and (4) the plants usually shatter freely. These are all characteristics of the wild species. In seed

oats false wild oats are objectionable but are much less harmful than wild oats.

142. Preparation of the Seed.—Next to selecting the best variety, the use of the best seed of that variety is of prime importance.

Three precautions should always be taken when preparing the seed for sowing: (1) to test it for germination.

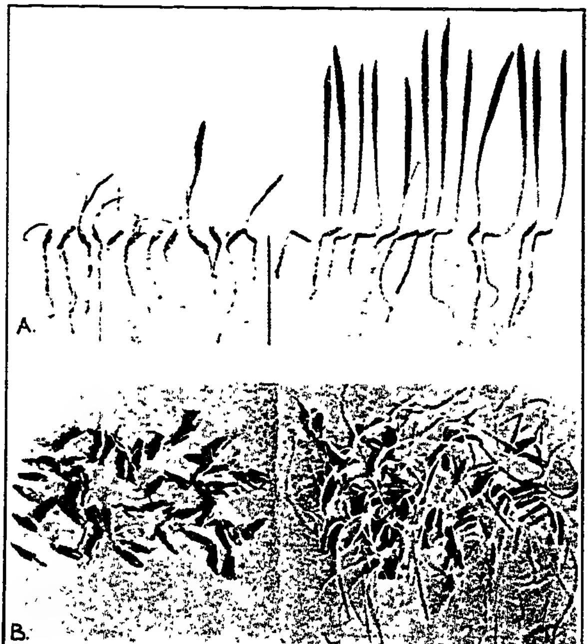

Fig. 59.—Testing Oats for Germination.

(B) Samples of oats after having been in the germinator 6 days. Low germination and vigor is shown in the sample at the left by the small number of seeds that have sprouted and by the weak growth. From appearances there was nothing to indicate that this sample was in any way inferior to the one at the right. (A) Representative plants of 12 days' growth from the two lots of oats shown in (B).—By courtesy Dominion Seed Branch.

(2) to clean it thoroughly and (3) to treat it for disease.

143. The Necessity for a Germination Test. — Even before the grain is cleaned it should be tested for percentage germination. In the event of its being of too low vitality to warrant its use for seed the work of cleaning will be saved. Of course the plumpest seeds such as would be selected by the fanning mill should be used for this test. Seed that is off color, dull, faded, weathered, musty or frosted is likely to be low in vitality. A black streak beneath the crease when the grain is cut lengthwise usually indicates frost in oats. The seed may be plump, of good color and to all appearances excellent for seed, and at the same time may be so severely damaged by frost that it is practically useless for sowing. A germination test is the only way to determine whether the seed will grow, how much of it will grow, and how vigorously it will grow.

144. Cleaning the Seed.—In an investigation made by the Dominion Seed Branch into the character of seed oats being used in different parts of Canada it was found that over 40 per cent. of the samples taken from the West were found to contain noxious weed seeds, one sample containing 2,100 per pound, and the whole number averaging 84 per pound. Nearly 90 per cent. of the samples contained other weed seeds as well, one having 6,429 per pound, the average being 260.

Cleaning oats with a fanning mill will not always result in a perfect seed sample. Most weed seeds other than wild oats can be taken out but the latter cannot be entirely removed. They must be prevented from getting into the seed. Nevertheless, thorough cleaning will do much to lessen or at least retard the ill effects of the

serious situation revealed by the figures quoted. Many farmers reduce the bulk of their seed from one-third to one-half in the process of cleaning and grading. This gives a uniform sample which usually results in a more even stand, more uniform ripening, somewhat increased yields and often a better grade.

145. Seed Treatment for Disease.—Where oats are not treated, smut increases just as in wheat and barley. There is less excuse for this disease occurring in oats than in other grain because both the smuts that attack oats (the "loose" and the "covered") can be effectively controlled by the formalin treatment—using the same strength of solution as for wheat.

The bluestone treatment is not recommended for oats, because (1) it takes more trouble to prepare, (2) there is some danger of injuring the vitality of the seed since a longer action of the chemical is necessary, due to the protective hull of the oat, and (3) it costs several times as much.

The hot water treatment will kill the spores of both of the oat smuts but it is too involved and laborious a process for the farmer to undertake in treating large quantities of grain.

146. The Time to Sow.—Oats mature in a shorter time than wheat, and are rather less hardy in the spring. The common practice is therefore to sow oats after the wheat seeding is finished. Except in areas where wheat is not grown this is the general practice. Where no wheat is grown, oats are sown somewhat earlier. In a four-year test at Saskatoon, the April 30th seeding gave the largest yield in each of two years, the May 20th in one, and the May 30th in another. The average for April 30th and May 10th seeding was the same, and

higher than all other seedings. Among farmers rather later seeding is commonly practised. (14)

147. The Amount to Sow.—Ordinarily 2 to 3 bushels of seed is sown per acre but as little as 1 and as much as 5 have been used in different parts. In the low altitudes of the Chinook region less seed is used, usually 1½ to 2½ bushels per acre, while on the heavy soils of the more moist areas and in the north 2½ to 4 bushels is often sown. About 2½ bushels is the customary amount used in most parts of the West. (15).

Fig. 60.—"Side" or "Mane" Type of Oats.

148. Depth to Sow.—What has been said about the depth to sow in secs. 16 and 108 applies also to oats. It is perhaps only necessary to add that since oats are frequently sown on stubble or fall or spring plowing, deeper seeding under these conditions is advisable. (16).

149. Place in the Cropping System. — In the chief wheat growing regions oats are sown after wheat and generally as the last crop before fallowing. Where barley is grown it is usually sown after oats or in the same year of the rotation.

In the heavy land areas in the more humid parts if oats are sown on fallow they are likely to lodge if the season is at all wet. In such of these areas where wheat matures too late to be grown on the fallow, there is no alternative but to grow oats. Under these conditions fallowing becomes less frequent and the time of plowing it later than in the drier parts. The fallow is also frequently modified by sowing oats very thinly in midsummer for pasture or hay. These three practices—less frequent fallowing, later plowing of the fallow and sowing oats thinly on the fallow for pasture or hay—result in the next season in an earlier, stiffer strawed and safer crop, but a rather less productive one. In the more moist parts of the park belt as well as in the higher altitudes of the Chinook belt oats is generally used as the first crop on breaking.

150. Preparation of the Land. — Where oats follow wheat or other grain crop in the more moist parts of the West the preparation is generally fall or spring plowing. In the drier parts of the wheat regions, spring plowing is, as a rule, preferred for oats, and wheat is usually sown on the fall plowing. The relative value of fall and spring plowing seems to be determined by the condition of the soil when the plowing is done. If it is in good condition in the fall it gives fair results, but if dry and lumpy unfavorable returns are probable unless timely rains occur. In spring the land is usually in good condition for plowing in this climate. Fall plowing gives relatively better returns in the areas having the greatest rainfall.

When two crops only are taken between fallows, oats are sometimes stubbled in. This practice gives fair returns on clean land that has been thoroughly fallowed

the second year previous and that is in good condition. On weedy fields or those having much grass as well as on soils that bake, this practice is not advisable. It is most common in the dry parts and on new soils that are free from sloughs. It is practised least in the older and more humid districts.

Land plowed in the fall for oats should be well harrowed down, except where drifting is likely to occur. After spring plowing it is well to sow as soon as possible after the operation. A good harrowing is generally given before seeding and the land packed and harrowed afterwards.

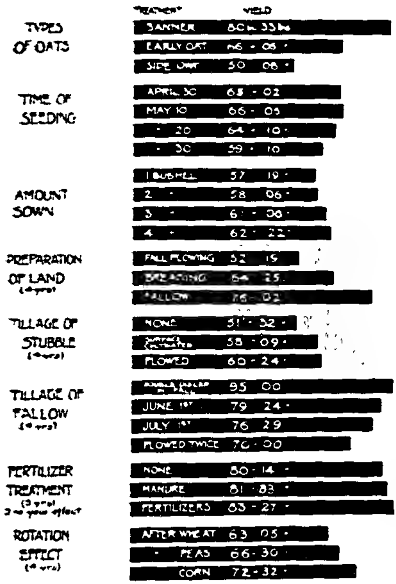

Fig. 61.—The Culture of Oats. Chart showing the result of tests at Saskatoon.

The following extracts from the summary of many years' tillage tests in the semi-arid plains of the United States may be of interest here:

"At stations north of Hays, spring plowing has been generally more productive of oats than fall plowing.

"At Garden City and all stations north of North Platte discing corn ground has been productive of higher average yields of oats than either fall or spring plowing.

"Subsoiling has not been a profitable practice, as the profits by it have been less and the losses greater than by fall plowing.

"Oats following summer tillage produced the highest average yields at all stations except Hettinger, where the yield was exceeded only by that on disced corn ground. While the expense of the method has prevented its being the most profitable, the degree of insurance which it affords against failure of the feed crop might justify its practice in oat production in at least some sections of the Great Plains.

"Discing corn ground yielded the highest profits of any method tested at all stations except Garden City and Dalhart."

151. Fertilizers for Oats.—Since oats are inclined to be weak in the straw the application of manure or other fertilizers sometimes causes lodging particularly on rich soils and fallowed fields. This danger is, of course, greatest in areas of highest rainfall and least in the drier parts. Under such conditions a thin application may with profit be made in the fall winter or spring before the second crop, the manure to be plowed under and the soil well firmed afterwards. In the lighter, poorer soils in moist areas as well as on all soils in the extremely dry parts manure gives very favorable results, even when plowed under in the fallow year. While commercial fertilizers are seldom or never used it is probable that phosphate will give better returns on most soils than either nitrate or potash.

152. Harvesting and Curing.—Oats should be cut as soon as they reach the firm dough stage. Earlier cutting results in a lower yield, while if left after this time some loss from shattering is likely to occur. The possible

danger of injury from wind and hail, and delay as a result of rainstorms suggest the advisability of keeping well ahead with the harvesting operations.

Oats are harvested both for hay and grain in exactly the same fashion as wheat. (sec. 110). The stooks are

Fig. 62.—Oat Crop Being Harvested and Stooked in One Operation.

put up in the same way and when stacking or threshing is done the work is accomplished in a similar manner as for wheat (secs. 111 to 115).

153. Storing and Shipping.—A large portion of the oat crop is stored in movable granaries where the threshing is done or in permanent granaries at the farm buildings. The storing and shipping facilities for the oats that enter into commerce are similar in every essential detail to those for wheat and other grains. (secs. 116 to 119).

154. Grades of Oats.—The grades of oats as defined in the Canada Grain Act are as follows:

Extra No. 1 Canada western oats shall be white, sound, clean and free from other grain, and shall contain 95 per cent. of white oats, and shall weigh not less than 42 pounds to the bushel.

No. 1 Canada western oats shall be white, sound, clean and free from other grain, shall contain 95 per cent. of white oats, and shall weigh not less than 36 pounds to the bushel.

No. 2 Canada western oats shall be sound, reasonably clean and reasonably free from other grain, shall contain 90 per cent. of white oats, and shall weigh not less than 34 pounds to the bushel.

No. 3 Canada western oats shall be sound, but not clean enough or sufficiently free from other grain to be graded as No. 2, and shall weigh not less than 54 pounds to the bushel.

No. 1 black or mixed oats shall be sound, clean, free from other grain, and weigh not less than 36 pounds to the bushel.

No. 2 black or mixed oats shall be sound, reasonably clean, reasonably free from other grain, and weigh not less than 34 pounds to the bushel.

Extra No. 1 feed oats shall be sound, except as to frost, shall contain not more than two per cent. of wheat nor more than two per cent. of other grain, shall be reasonably clean and shall weigh not less than 38 pounds to the bushel.

No. 1 feed oats shall be oats excluded from the preceding grades on account of damage other than heating, shall contain not more than five per cent. of wheat, nor more than three per cent. of other grain, shall be reasonably clean, and shall weigh not less than 34 pounds to the bushel.

No. 2 feed oats shall include oats weighing less than 34 pounds to the bushel or otherwise unfit for No. 1 feed.

155. Insects Affecting Oats. — The common insects affecting oats are discussed in Chapter XIV.

156. Diseases of Oats.—The chief diseases of oats are smuts and rusts. Two forms of smut are found on this crop, namely, the "loose" or "naked" smut and "covered" smut, the former being by far the more common.

The "loose" smut destroys the kernel, the hull and the chaff. The heads become stunted and the branches supporting the glumes containing the dark brown sooty mass of smut spores, stand erect and close to the central axis of the head, instead of spreading out as in a normal head. About flowering time the spores are scattered by the wind and are blown to other plants, many of them probably lodging within the open glumes of the flowers. The spores remain in a dormant stage on the seed over winter. In the spring they germinate when the seed starts to grow and set up a fungus growth in the young seedlings. At flowering time this growth again produces the black masses of spores or seeds in the panicles of the plants.

The "covered" smut of oats has practically the same life history. It differs from the "loose" smut in producing a normal ear, except that the grain is replaced by a spore mass covered by a thin whitish membrane and the spores are not dispersed before harvesting time but during the threshing process. The spore when viewed under the microscope is smooth while that of the "naked" smut is rough. Both oat smuts can be controlled by the formalin treatment.

Fig. 63.—The Smuts of Oats.

(A) Covered smut of oats; note the more natural appearance of the ear as compared with (b) the naked or loose smut of oats. —By courtesy H. T. Gussow.

The Black Stem-rust (*Puccinia graminis*) and the Crown-rust (*Puccinia coronata*) are the two rust diseases which attack the oat crop. The Black Stem-rust is similar in appearance and life history to that which attacks wheat and other cereals and is also the most destructive rust to oats in this country. The life history of the Crown-rust is very similar except that its secondary host is the Buckthorn instead of the Barberry, as in the case of the Black Stem-rust. It does less damage than the Stem-rust, chiefly because it usually attacks the

leaves and not the stems of the plants. It gets its name from the peculiar projections at the top of the winter spore which gives it the appearance of a crown.

Damage from rusts may be lessened by having an early crop, by using the varieties which avoid or resist rust and by destroying other hosts of the disease such as wild grasses and the secondary hosts. No particularly rust-resistant varieties of oats are now grown in this country but the early varieties tend to avoid rust.

CHAPTER VI

BARLEY

The Feeders' Grain.

In pre-prohibition days barley was commonly spoken of as the "brewers' grain": at the present time it may more appropriately be described as the "feeders' grain", since by far the greater part of it is used for stock feed and only a small proportion for brewing purposes. Aside from its feeding value for animals its chief advantages for this climate arise from its earliness of maturity. It ripens in fewer days after seeding than any other class of grain crop, thus permitting its use (a) as a cleaning crop after late spring cultivation to control weeds, (b) as a crop to be sown and harvested early to permit of after harvest tillage, (c) as a crop to be harvested before many weeds such as wild oats drop their seed, and (d) as a grain crop for the shorter growing season of the far north.

157. History of Barley.—*"Barley was cultivated by the people of western Asia nearly 2000 years before the Christian era. Pliny makes the statement that barley was among the first cereals cultivated for food. This grain is mentioned by early writers in Egypt, and the high esteem in which it was held is shown by the fact

* From Farmers' Bulletin 443—United States Department of Agriculture.

that Egyptian coins estimated to be several thousand years old bear figures of barley heads. Specimens of this grain taken from Egyptian tombs, estimated to be over 3000 years old, are in the British Museum. Representations of barley heads are also found on these tombs.

"As a crop barley is mentioned in Exodus and in other

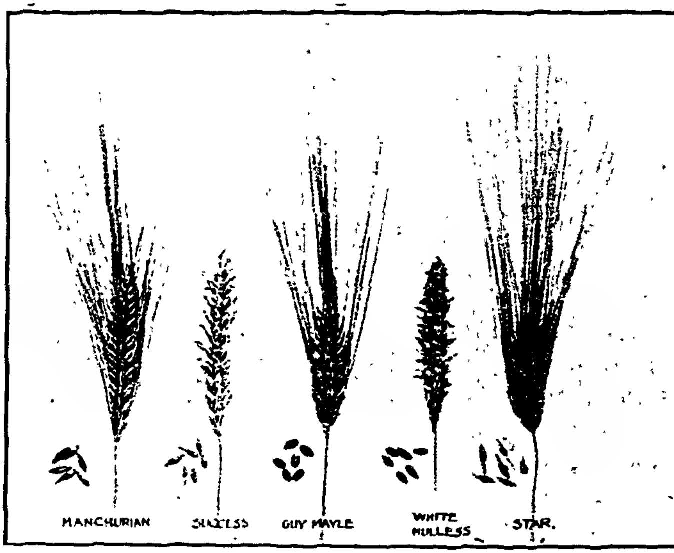

Fig. 64.—Heads of Different Types of Six Row Barley.

books of the Bible, and from all indications the greater portion of the grain in Biblical times was barley. It was evidently among the chief food-producing plants of the Jewish race and of the surrounding nations. From western Asia barley was early introduced into southern Europe and gradually spread northward. Its cultivation in early times is shown by the finding of charred grains in the homes of the pre-historic people of Europe.

Ancient historians, including Pliny and Theophrastus, refer to the value of this grain for both food and drink. . . . After the introduction of wheat and rye these grains gradually replaced barley for human food, especially in Europe, but it is still used as human food in portions of western Asia."

158. Barley as a Food.—* "Until modern times the principal use of barley has been for food, although it has long been used also for beer. As a bread-stuff barley has always ranked lower than wheat. It has served chiefly as a food for the poorer classes who could not afford much wheat. The ancients used to feed their athletes on barley bread, in the belief that it was an especially strengthening food. From their use of this food the Roman gladiators were called *hordearii*, or "barley boys", as we may freely translate it, much as the name of "beef eaters" is now applied in England to the yeomen of the royal guard. In the great armies of antiquity barley was largely used as a food for both man and beast . . . As a human food . . . it is now used only to a comparatively small extent throughout the world. With us it is eaten almost entirely as "pearl-barley". This consists of the kernels deprived of their outer coverings and rounded. It appears in modern cookery chiefly as an addition to broths or soups. The nutritive value of barley is usually less than that of either wheat, oats or rye. From being the grain most used as food by the ancients barley has now come to be eaten less than any other grain . . .

159. Barley, a Source of Beverages.—"In southern Europe and other regions where the wine grape grows

* From "Corn Plants", by Sargeant, by courtesy Houghton, Mifflin & Co.

well, wine is the common drink; and the brandy, which is distilled from wine, is the form of the spirit most in use. In such regions as northern Europe, however, which are too cool or too dry for wine growing, the popular alcoholic drinks are obtained from grains. That is to say, whiskey and gin, which are distilled mostly from rye or maize, largely take the place of brandy; while beer, ale and the like, which are made principally from barley, serve much the same purpose as wines. These facts add interest to the following statement of the ancient Grecian historian, Herodotus, regarding the Egyptians of his day: 'They use,' he says, 'wine made of barley, for they have no (grape) vines in that country.' What Herodotus meant by 'wine made of barley' was doubtless a sort of beer similar to what is brewed from barley to-day. . . . .

"Brewers prefer barley to any of the other grains for malting, because of its exceptionally ready germination. Its very general use for beer-making is favored also by the fact that it thrives over a wider range of climate than any other "corn" plant. It grows well even farther north than oats, and at the same time will flourish in subtropical soil."

160. The World's Barley Crop. — *"Russia is the world's largest barley producer. The average Russian export of barley is more than 25 per cent. of the crop, most of which is grown near the Black Sea.

"Barley reaches its largest importance relative to the population and to the land in crops in Algeria and in the north of Africa generally. In Libya, in 1909-1910, it occupied 50 per cent. more area than wheat. The crop

* From "Geography of the World's Agriculture", by Finch and Baker.

is sown in November to utilize the winter rains; it is harvested in April or May, and thus avoids the dry summer. The bright grain of these dry regions is in demand for malting.

"The barley crop of India has increased greatly during recent years. It is grown mostly in the valleys of the

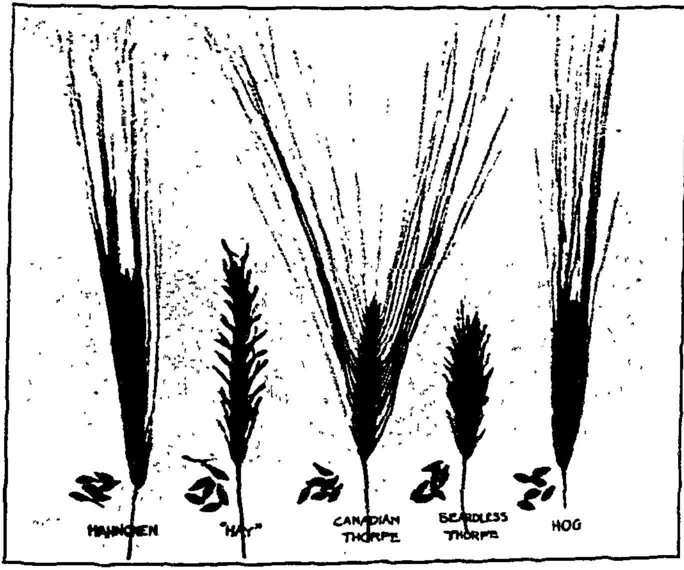

Fig. 65.—Heads of Different Types of Two Row Barley.

Ganges and Indus Rivers, largely in the area intermediate between the regions devoted to wheat and to rice. The crop supplements the other food cereals and is an important article of export.

"Barley is the second cereal crop of Japan. Ordinary barley is largely grown as an upland crop in that country. Naked barley is also grown as a second crop after

rice on the lowlands, but rice is the more important crop. Barley mixed with rice is the common food of the country people.

"Barley is steadily increasing in importance in the United States. The rapid progress in production is due principally to two causes—the settlement of the west, in which climatic conditions are especially favorable for barley, and the gradual development of its cultivation in the east, where it is used to an increasing extent for feed.

"Seven North American barley districts have been recognized by Carleton. In the northeastern district about three-fourths of the crop of the continent is grown, and six rowed barley gives much the higher yield, the principal variety being Manchuria. In the southern district winter barley is grown and although as yet the production is exceedingly small, the crop is rapidly increasing in importance as a feed for live stock. The Northwestern Plains is a two-rowed barley region. In this district and the Gallatin Valley of Montana the major portion of the North American production of these varities is grown. The crop is very clean and of good quality. In the southern plains district both six-rowed and two-rowed varieties are grown in the northern portion, and winter barley in the southern. The production of this district is small. In the western intermountain district two-rowed varieties are grown in the northern Rocky Mountain region, six-rowed principally in the south and in eastern Washington, while hulless and hooded varieties are also grown. In this district barley is grown both by dry-farming methods and under irrigation. In the south Pacific, or California district, climatic conditions are similar to those in the Mediterranean

region of Europe, and a local six-rowed variety, known as Coast barley, is chiefly grown. Barley is rapidly increasing in importance in this district. In the north Pacific district very little barley is grown as yet and the varietal adaptation is uncertain."

161. Barley in Canada.—Ontario and Manitoba are the largest barley producing provinces of Canada. each producing as much as Saskatchewan and Alberta together or between one-third and one-fourth of the total production. Quebec produces about one-twentieth of the Canadian crop, while in the other provinces very little is grown. Canada produces but a small share of the world's barley crop. The barley crop in the three Prairie Provinces is worth about one-twelfth as much as the wheat crop and one-quarter as much as the oat crop.

162. Uses of Barley in Western Canada.—In Ontario and Quebec the crop is grown because of its feeding value for hogs and cattle. In Manitoba its feeding value is appreciated but its culture is encouraged because of its value as a "cleaning" crop. In Saskatchewan and Alberta its earliness, its feeding value and its suitability as a cleaning crop all tend to foster its use. In the Prairie Provinces it is grown largely (1) where wild oats are a serious menace as in parts of southern Manitoba and south eastern Saskatchewan, (2) where there is danger from early fall frosts, as in the northern parts of all three Prairie Provinces, and (3) on fields that cannot be prepared early enough in spring for wheat or oats.

At the present time barley is third in acreage in Manitoba and Alberta coming after wheat and oats, while in Saskatchewan it is fourth, being exceeded by wheat, oats and flax. In Saskatchewan the barley acreage is likely to increase more rapidly than the flax acreage.

The chief faults of the crop in this climate are (1) its weak straw when grown on rich soil, (2) a tendency of the heads to break off and the seeds to shatter, and (3) the presence of beards on the best grain types.

163. Barley as a Cleaning Crop.—In southern Manitoba and the older settled portions of Saskatchewan, barley is used chiefly as a "cleaning" crop. Where wild oats and other weeds are prevalent the use of barley permits of more early spring cultivation before seeding and more fall cultivation after harvesting than any other grain crop. It ripens in such a short time that many weeds do not have time to mature their seeds before har-

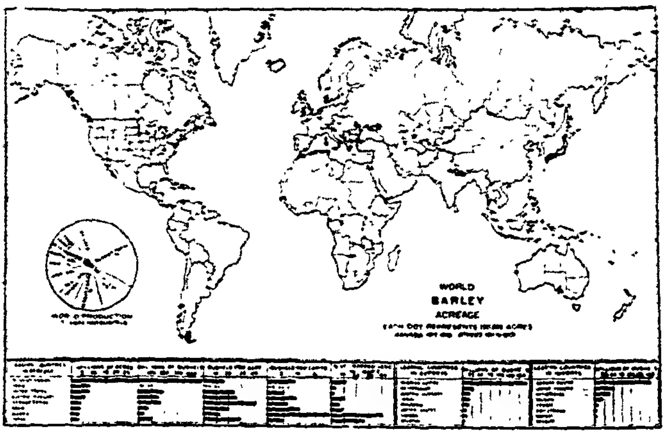

Fig. 66.—Distribution of the World Acreage of Barley.
By courtesy Finch and Baker Canadian Statistics revised.

vesting, particularly when early varieties are used and where the crop is cut for hay.

164. Barley for Northern Areas.—Barley is the most successful grain crop of the far north. It is not only grown successfully in all northern parts of the present settled area but reports from the furthest north outposts

of civilization in America, such as Fort Chipewyan in northern Alberta, Fort Liard north of north eastern British Columbia, Fort Norman in the North West Territories, just south of the Arctic Circle, and the United States Experiment Stations in Alaska. At these and other far north points officials of the Hudson's Bay Company, missionaries to the Indians or official agronomists report the successful production of barley.

165. Barley as a Feed.—*"On the Pacific slope, where corn or oats do not flourish, barley is extensively used as a feed for animals. The horses of California are quite generally fed on rolled barley with wheat, oat or barley hay for roughage. Barley is the common feed for dairy cows in northern Europe. The Danes sow barley and oats together in the proportion of one part of barley to two of oats, the ground mixed grain from this crop being regarded as the best available feed for dairy cows and other stock. Fed with legume hay to fattening steers and lambs, barley has given nearly as good returns as corn. For horses barley is somewhat less valuable than oats. At the Virginia Station calves made excellent gains on barley and skim milk, but corn proved cheaper. In Great Britain and northern Europe barley takes the place of corn for pig feeding, leading all grains in producing pork of fine quality, both as to hardness and flavor. In American trials somewhat more barley than corn has been required for 100 lbs. gain with fattening pigs. . . . Barley is somewhat higher than corn in crude protein. It is still decidedly carbonaceous in character, and should be fed with legume hay or with a nitrogenous concentrate for the best results."

* From "Feeds and Feeding", sixteenth edition, by Henry & Morrison.

166. The Choice of Varieties.—There are many different types of barley, and many varieties of each type. Those best suited for grain production are the bearded six-row, and bearded two-row types. Two beardless types, viz., the beardless hulless and the beardless hulled are occasionally grown for forage. "White Hulless" is typical of the former and "Success" of the latter. No bearded naked barleys are grown to any extent in the West.

The six-row bearded type as represented by Manchurian and O. A. C. No. 21 is considered the best for the park belt and wooded areas and the eastern part of the prairie area. The two-row varieties promise most in the western prairie section, particularly in the lower altitudes of the Chinook belt.

The Dominion Experimental Farms in the three Prairie Provinces recommend Manchurian and O. A. C. No. 21 as the most suitable six-row sorts, and Duckbill and Early Chevalier as the best two-row types. The Duckbill is a similar type to Canadian Thorpe and Early Chevalier is similar to Hannchen. Other good six-row varieties sometimes recommended are Odessa and Mensury.

Two very early short strawed, six-row, bearded hulled varieties, one brought in from Sweden and christened "Early Six", the other introduced by Dr. Chas. Saunders and called "Albert" promise much at far north points, although their yield is lower than the later varieties. A variety of the true six-row barley called California which was introduced to southern Alberta from Idaho by Mr. Don. H. Bark of the C. P. R. Natural Resources Department, has yielded exceptionally well in several tests.

The agricultural experiment stations in North Dakota and Montana recommend the six-row varieties for eastern North Dakota and the two-row sorts for western North Dakota and Montana. White Smyrna, a short strawed two-row sort, is reported to be the highest yielder on the dry lands of Montana. The experience of these stations and results secured at Saskatoon and Lethbridge suggest that on the dry lands in the prairie section of western Saskatchewan and eastern Alberta, particularly in the southern part, the two-row varieties are worthy of serious consideration. At Saskatoon "Hannchen" a two-row sort has yielded more every year, with one exception, than any other variety. It may be too short in the straw for the driest parts, but is well worthy of trial.

Fig. 67—*Table showing five-year average yields of different varieties of barley at different stations—data for each station is comparable but as between different stations not necessarily so.*

	Brandon.	Indian Head.	Saskatoon, 1911-17 incl.*	Scott, 1912-15 incl.	Rosthern.	Lethbridge, 1912-15 incl.	Lacombe, 1912-15 incl.
	bus. lbs.	bus. lbs.	bus. lbs.	bus. lbs.	bus. lbs.	bus. lbs.	bus. lbs.
Manchurian ...	72-20	77-09	44-11	40-32	....	41-38	64-22
O. A. C. 21 ...	66-37	85-46	43-16	45-00	73-20	46-46	66-10
Mensury	74-07	....	....	....	....	....	....
Mansfield	....	....	....	....	....	47-46	70-25
Odessa	62-33	....	....	....	64-12	53-21	65-46
Black Japan ...	....	....	....	42-23	72-44	....	....
Stella	....	79-12	....	....	66-24	....	60-00
Invincible	....	67-14	....	....	....	50-15	....
Hannchen	....	....	51-30	....	....	....	....
Gold	71-23	....	....	....	....	....	....
Swedish Chev...	60-03	69-27	....	....	62-02	50-41	....
Early Chev. ...	....	....	....	41-27	61-06	38-36	....
Can. Thorpe ...	60-34	70-25	41-29	....	....	....	....
Duckbill	....	....	....	55-31	65-45	....	....
Guy Mayle	....	....	33-27	....	....	37-28	42-34
Success	....	....	33-00	18-26	....	....	26-22
Improved White Hulless	....	....	31-36	....	....	....	....

* Not including 1913.

167. Description of Important Types.—*The six-row bearded hulled barleys.*—This type of barley is heavy in yield, medium early in maturing and fairly strong in the straw for barley. It is richer in protein than the two-row sorts. In Europe it is not liked for malting purposes, but in the north western States the malsters favor it. It is considered to be better suited to Manitoba, eastern and northern Saskatchewan and northern Alberta than any of the other types. It includes the "true" six-row as represented by the California and Star varieties, and the ordinary six-row (sometimes spoken of as four-row) such as O. A. C. No. 21 and Manchurian.

Two-row bearded hulled barley.—This type of barley is rather longer in the straw and a few days later than

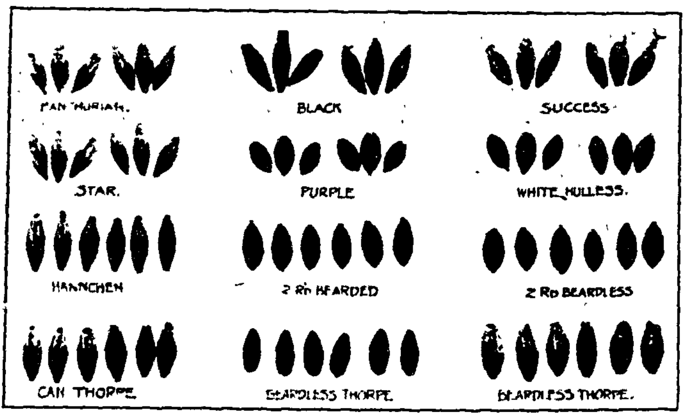

Fig. 68.—Seeds of Different Barley Types.

the six-row type. Most two-row varieties are less productive in the park belt and wooded areas and in Manitoba and eastern Saskatchewan than those having six rows. Two types of two-row barley are commonly grown

the Chevalier type and the Duckbill type. Hannchen and Gold, pedigree varieties introduced from Sweden, are the most productive of the Chevalier or long narrow headed type, while Canadian Thorpe and Duckbill are good varieties of the Duckbill or compact headed type. The latter is rather taller and thought to be somewhat stiffer in the straw than most other barleys and therefore often recommended for rich soils, where the crop is likely to lodge.

Miscellaneous barley types.—The beardless barleys are less productive but earlier than those mentioned above. They are seldom grown for grain, although in the older parts of the West where they are frequently used as a cleaning crop for wild oats, they are occasionally threshed. They are popular in some parts as early maturing annual hay crops. White Hulless, a six-row barley of the beardless, hulless type is not dissimilar in growth characteristics to Success, which is six-rowed, beardless and hulled, except that it is shorter. Both are used largely for forage. White Hulless, as the name implies, loses its hull in threshing, while Success does not.

The bearded hulless or bearded naked barleys are seldom grown. They are short in the straw and low in yield in the northern parts, but they are very early. They have produced fairly satisfactory returns in Montana and western North Dakota. No Canadian stations have yet found sufficient reason to recommend them. Black Hulless and Guy Mayle, six-row bearded naked barleys, and Hogg, a two-row bearded naked white sort, are among the most commonly used hulless bearded varieties.

168. Place in the Rotation.—Barley is generally grown as the last crop in the rotation and on the poorest pre-

pared land. Since it is used chiefly as a stock food the presence of volunteer grain of wheat, oats or rye is not a serious fault except in fields grown for seed. When grown for the latter purpose exclusively it should be grown after corn or on sod land. If planted on fallow it is likely to lodge if the land is heavy or the season wet. In Manitoba its use as a nurse crop when seeding down to grasses or clover is increasing.

169. Preparation of the Land.—*"The heavier types of soil can be handled best by plowing in the autumn. Turning the soil at this season of the year leaves it exposed to the frosts of winter, and it can be cultivated and handled much more readily the following spring. Where it is not possible to plow in the fall and the land needs this treatment, it should be turned early in the spring and worked down with disc and drag harrow. If the soil is loose and open the packer will assist in bringing the furrow slice into a firm condition, and will prevent undue loss of moisture. The field can be cultivated once or twice before seeding. This eradicates a large number of the small weeds which appear at this season.

On the lighter types of soil spring plowing is preferable. The plow should be followed closely with the packer and harrow, and the seed sown as soon as possible. If each day's plowing can be packed, harrowed and seeded the same day as plowed, so much the better. Where spring plowing is practised it is advisable to disc the land the previous fall, as this induces the germination of weed seeds, which the frosts of winter will destroy. Incidentally it reduces the loss of soil moisture. In the

* From "Barley Growing in Manitoba", by the Department of Field Husbandry, Agricultural College, Winnipeg.

spring the harrow should be used from time to time, thus destroying several successive crops of weeds."

170. Fertilizers for Barley.—Farm yard manure gives the best results when applied before corn or some other forage crop, but where these are not grown it will give very satisfactory results if applied before barley and plowed in. This applies particularly to Manitoba and to parts of Saskatchewan and Alberta. In the drier parts similarly favorable results obtain if three precautions are observed (1) to apply the manure thinly, (2) to firm the soil well after plowing, and (3) to use either well rotted manure, or the finer, less coarse material of green manure.

Fig. 69.—The Smut Diseases of Barley. (A) Various stages of the loose smut of barley. (b) Barley ear affected with covered smut.—By courtesy H. T. Gussow.

171. Smut Diseases of Barley.—The barley plant is subject to attack from two smut diseases—the covered smut and the loose smut. The covered smut is less prevalent than the loose smut and is easier to control. The

formalin treatment as described in sec. 9 is best for the covered smut. The loose smut is, however, not killed by this treatment. The hot water treatment is the only satisfactory one for this disease. (See sec. 13).

The development of the loose smut of barley and the treatment recommended for it in the barley sections of Wisconsin are as follows:*"The loose smut is noticeable as soon as the barley begins to head. The black masses of spores may then be seen pushing out from the sheath in which they are inclosed.

A few days after the smut makes its first appearance it will have ripened and be wafted by the wind to its hiding place in the immature kernel of barley where it remains secure until the kernel is planted the following year or later when it infects the young seedling. After the smut is blown away nothing is seen to indicate smut except the light blackened tip of the barley plant, where the spike should be.

172. Treatment to Prevent Loose Smut.—"Place the barley in gunny sacks and submerge in cold water for 12 hours. Remove and drain for one hour then submerge for five minutes in a cask containing hot water, held at a constant temperature of 130 degrees Fahrenheit. It is well to warm the barley before placing it in the water at 130 degrees by submerging it in water at a slightly lower temperature for a minute or two to take off the chill, otherwise the temperature in the cask that should be held at 130 degrees would be materially lowered. Boiling water should be kept near at hand which can be added at intervals to keep the temperature nearly constant, but should never be allowed to come into direct

*From Wisconsin Bulletin No. 212 on "Barley Culture in Wisconsin".

contact with the grain as its vitality will be injured or destroyed.

"The seed should be spread upon the barn floor to cool before sowing. It should be sown preferably the same day or not later than the day after treatment, otherwise it will sprout and difficulty will be experienced in getting it through the seeder or drill. This treatment is known as the modified "Swingle Hot Water Treatment" and is used by this station (Wisconsin) with entirely satisfactory results eradicating approximately all the smut.

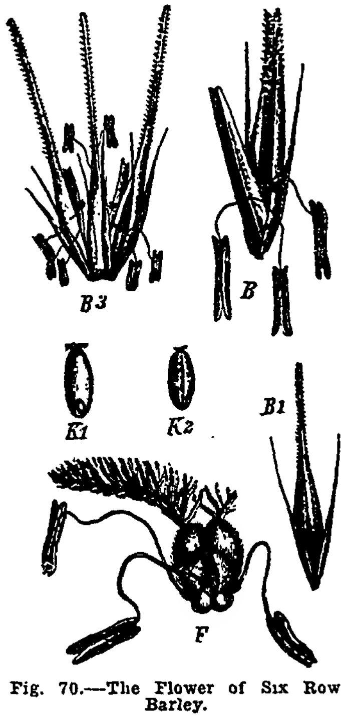

Fig. 70.—The Flower of Six Row Barley.

B3 A group of three spikelets from node of the rachis. B.B.1, single spikelets. F, a flower (stigma partly removed). K1, K2, back and front views of kernel.—From Sargent after Nees.

"The margin of temperature which is effective for the destruction of the smut spore is so narrow that the operator must be supplied with a good standard thermometer and watch the progress closely. If the water in which the seed barley is submerged is but a few degrees lower the treatment will not be effective because the smut germ is not killed. On account of the liability of error it is

advisable for barley growers to treat only a sufficient amount of seed to sow two or three acres and save seed for future sowing from this particular field which will have little smut in it."

173. Time to Sow Barley.—In Manitoba the barley seeding is usually done between the 10th and 25th of May although earlier and later seedings are frequent. At Saskatoon sowing on May 10th has given larger average yields than any earlier or later seedings, and the dates recommended for central Saskatchewan are May 5th to 20th. At Lethbridge, Fairfield reports good results from seedings the first of May. The data available, indicates that sowing during the first three weeks of May is likely to give the largest return but that later seedings may be made where weed control and a supply of forage are the chief considerations. (See Sec. 14.)

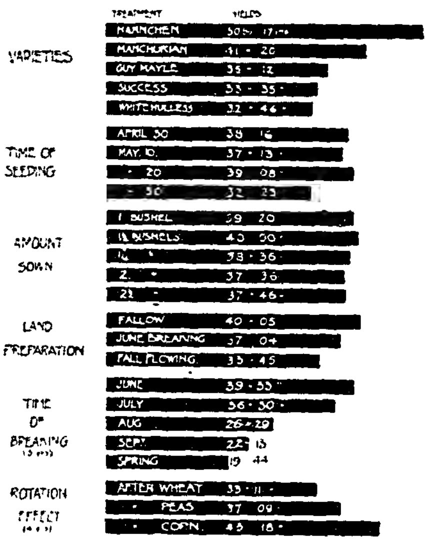

Fig. 71.—The Culture of Barley. Summary of tests at Saskatoon.

174. Amount to Sow.—In Manitoba 1½ to 2 bushels per acre is commonly used. In Saskatchewan 1¾ bushels is generally sown. In Montana the amount recommended is 1¼ bushels per acre. The average yield at

Saskatoon for four years both on fallow and fall plowing was greatest with six-rowed barley when 1½ bushels was sown. The seed used contained about 16,000 seeds per pound. Hannchen averages about 14,000 and Canadian Thorpe, 12,000 per pound. A quarter bushel more is recommended where the larger seeded two-rowed varieties are grown. The rate should be increased as more humid conditions are found, and might be decreased slightly in areas where a lower average precipitation obtains. (See Sec. 15).

175. Harvesting Barley.—Where barley is grown for brewing purposes it is seldom cut before it is well ripened, at which time the straw and heads are of a golden yellow color. Since our barley is largely grown for feed and since with well ripened barley there is likely to be a greater loss of heads by breaking off and of seeds from shattering, rather earlier cutting is to be preferred here. If the barley is to be sold the stooks might well be capped, and the threshing done before any discoloration of the seeds resulting from weathering occurs. Harvesting is always done in this country with the binder.

176. Threshing Barley.—When barley is grown for feed it is quite permissible to thresh it "close". The malster, however, desires a perfect and uniform germination, and it is found that threshing close or breaking the awns off too close to the seed lessens the uniformity of the germination. For brewing purposes, therefore, less close threshing is desirable. The soundness, plumpness, lustre, bushel weight and freedom from weeds and other grain determines the grade of barley.

177. Grades of Barley.—The grades of barley as defined by the Canada Grain Act for the Western In-

spection Division, which includes the three Prairie Provinces are as follows:

No. 1 Canada Western barley shall be plump, bright, sound, clean and free from other grain, and shall weigh not less than 48 pounds to the bushel.

No. 2 Canada Western barley shall be reasonably clean and sound, but not bright and plump enough to be graded as No. 1, and shall be reasonably free from other grain, and weigh not less than 48 pounds to the bushel.

No. 3 Extra Canada western barley shall be in all respects the same as No. 2 barley, except in color, weighing not less than 46 pounds to the bushel.

No. 3 Canada Western barley shall be reasonably clean and reasonably free from all other grain, shall include weather-stained and slightly shrunken, but sound barley, and weighing not less than 45 pounds to the bushel.

No. 4 Canada Western barley shall include all damaged barley weighing less than 45 pounds to the bushel.

178. Disease and Insect Enemies of Barley.—The chief diseases of barley are the covered and loose smuts. The control of these is discussed in Sec's. 9 to 13 and in Sec's. 171 and 172. Rust also affects barley but seldom seriously in this climate. The preventive measures for rust in wheat, apply also to the barley rust. (See Sec's. 125 to 127).

The insect enemies of barley are largely the same as those affecting wheat. These are indicated in Sec. 121 and discussed in detail in Chapter XIV.

CHAPTER VII

RYE

The Grain of Hardiness.

Rye will grow on poorer soils than most other cereals, and on account of its lower price furnishes a large part of the food supply of some of the poorer races of people. For these reasons it has been called the "Grain of Poverty". Under Western Canadian conditions it may more accurately be called the "Grain of Hardiness" since it will withstand greater extremes of cold and drought than any other grain crop.

179. The Distribution and Uses of Rye.—*"Rye is very largely (about 96 per cent.) produced and consumed in Europe. As a crop it is of greatest relative importance in the German Empire, the Netherlands, Russia, Belgium, and Austria-Hungary. Only in the the last named country does wheat out-rank rye in the proportion of the cropped land occupied. In Russia the two crops are of nearly equal importance.

"The zone of largest acreage in Russia lies in the region bordering the spring-wheat district, where the temperatures are far too severe for winter wheat. The yields obtained in this section are low (12 bushels per acre), but greater than those of wheat. The rye belt

* From "Geography of the World's Agriculture", by Finch and Baker.

of Poland and Prussia is in the main in regions of sandy soils, cool summers, and cloudy skies. In Western Europe the capacity of rye to yield returns on areas too poor or too wet or bleak for wheat is shown by its occupation in France of the Highlands of Brittany, of the central Plateau, and of the Landes. The same may be said of the rye in Northwestern Spain. The absence of rye from the non-wheat-producing areas of the United Kingdom may, no doubt, be largely attributed to a national prejudice against rye products.

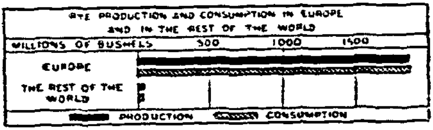

Fig. 72.—Rye Production and Consumption. About 96 per cent. of the rye crop of the world is produced and consumed in Europe.—After Finch and Baker

"Rye is now of only local importance in the United States, forming less than one-half of one per cent. of the total value of all crops in 1909. It is grown mostly in regions having a cool climate and sandy soils. The rye belt extends across the lake States about 300 miles north of the winter wheat belt.

"The States having an average yield of over sixteen bushels per acre are all located in the north. Rye, however, is grown in small quantities farther south than wheat, but principally for forage and green manure. The rye acreage of Western Michigan, Wisconsin, and Minnesota is densest in regions of sandy or loamy soils. In New England rye is often the first crop in a rotation designed to build up worn-out soils, and in the corn belt it is frequently sown in the standing corn or stubble in the fall and plowed under in the spring as a green-manure crop. It is also sometimes used as a winter cover crop in the Southern States to prevent

erosion and leaching, as well as to increase the vegetable matter in the soil.

"About two-thirds of the rye grain produced in the United States is used as food for domestic animals and about one-third for flour and for the production of alcohol and alcoholic beverages. In Europe rye is used mostly for bread but in the United States comparatively little rye bread is eaten, its use being virtually confined to those who have acquired a taste for it in European countries."

In Western Canada as yet it is but little grown. In 1916 it occupied about 30,000 acres in Manitoba, and 20,000 acres in each of Saskatchewan and Alberta, or less than one per cent. of the total acreage devoted to wheat. Ontario produces about as much as the three western provinces, and nearly half of the total Canadian crop. Rye is by far the least important cereal grown in Canada to-day.

180. The History of Rye.—Rye is supposed to have been developed from a wild form which is still found in some districts of southern and eastern Europe and western Asia. It is a cereal of comparatively recent origin. Pliny, writing in the century before the Christian era, mentions rye as a new plant, grown by the barbarian tribes captured by the Romans. Its early cultivation seems to have been carried on in western Asia and southern Russia, chiefly in the neighborhood of the Caspian Sea.

181. Adaptation of Rye.—Rye is the hardiest of the cereals. The winter varieties of rye will come through the winter safely much farther north than any of the other cereals and the spring varieties are grown

almost as far north as barley. According to Carleton* rye is grown to some extent north of the Arctic Circle in Finland, and in Norway it is found as far north as 69° N. latitude, which is 9° further north than the northern boundary of the Prairie Provinces. In the Himalayan regions in India rye is grown at an altitude of 14,000 feet and in southern Europe it is practically only at high altitudes that it is grown at all. At Rampart, Alaska, in latitude 65° 30' N. rye has matured seed for several years.

Rye will grow and produce a crop on soils that would be considered much too light and poor to produce a crop of wheat, but it will at the same time give a much better yield if conditions are made favorable for it.

182. Utilizing Rye Straw.—In the eastern portion of this continent, as in Europe, the straw as well as the grain of rye is a "cash" crop. There is a ready market for straw in good condition. When threshed carefully it is used in several manufacturing processes. This, it is reported, has resulted in the development of a type of threshing machine, in which the cylinder has either plain bars without teeth or has a tight corrugated surface. The sheaf is fed in sideways and an attachment at the rear very similar to the sheaf-producing portion of a binder, ties the threshed straw into convenient sheaves. The straw is sold in different grades varying according to its length, lightness in color and brightness. This is an industry that has not developed in the West, our chief use of the straw being for coarse fodder and bedding for animals.

183. Rye vs. Wheat.—The composition of rye is very similar to that of wheat, although it contains rather

*"The Small Grains", by Carleton.

less protein, and this is in a somewhat different form. Rye contains some of its protein in the form of gluten, which gives it the property, with wheat, of forming a dough which will give a light porous bread. The gluten of rye, however, is less in amount and of lower quality. Gluten in wheat flour is composed of glutenin and gliadin, which occur in varying proportions, but in strong baker's flour, about in the proportion of 40 of the former to 60 of the latter, these two forming the bulk of the protein content, less than one-tenth being made up of other proteins. The gluten of rye flour, on the other hand, has been shown by analysis to be made up almost entirely of gliadin, which results in a much poorer quality of gluten, and consequently detracts considerably from the "raising" power of the loaf. (Fig. 32).

Rye flour is of two kinds, "light rye flour" and "coarse rye flour" or "dark rye flour", which is com-

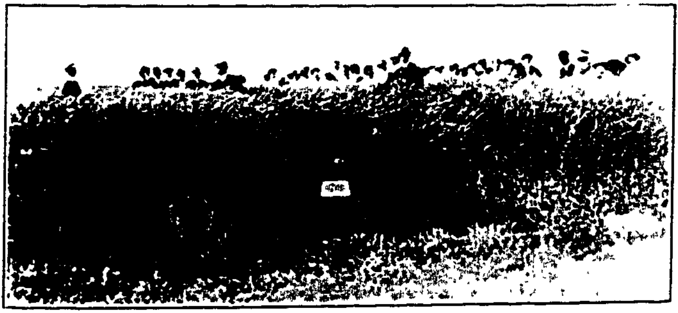

Fig. 73.—Among the Test Plots of Winter Rye.

parable to the graham flour of the wheat mills. In Europe, where coarse rye bread is in common use, it is considered as being superior to wheat bread, though

actual digestion experiments tend to show that the fine white flour is more nutritious.

184. Rye as an Animal Food.—*"Rye furnishes about one-third of the people of Europe with bread, and when low in price or off-grade is commonly fed to stock.

"The farm animals show no fondness for rye, but take it willingly when mixed with other feeds, as should always be done. Fed alone or in large amounts it is more apt to cause digestive disturbances than the other cereals. In northern Europe it is a common feed for horses and swine. Fed in large allowance to cows, rye produces a hard, dry butter, but a limited amount mixed with other feeds has given good results.

"The by-products in the manufacture of rye flour are rye bran and rye middlings, which are usually combined and sold as rye feed. All have about the same feeding value as the corresponding wheat feeds, each containing less fiber and being somewhat lower in protein and higher in nitrogen-free extract than the corresponding wheat feed."

185. Spring vs. Winter Rye. — Wherever winter grains can be safely grown in western America, they yield more than the spring-sown varieties of the same species. This is true of rye as well as of wheat. In Western Canada, winter wheat is not widely grown because it has not proven a safe crop outside certain areas in Southern Alberta and northern Manitoba, and spring wheat now occupies over 95 per cent. of the wheat acreage. Winter rye, on the other hand, is hardy enough for most conditions in the West and is consequently grown much more extensively than spring rye.

The winter-sown crop possesses several advantages. It yields more on the average, it furnishes late fall

* From "Feeds and Feeding", Sixteenth Edition, by Henry & Morrison.

pasturage and early spring pasturage when little else is available, it aids in the control of annual weeds and drifting soil, and it ripens before the general grain harvest, thus distributing the labor better. The quality of hay and grain is not essentially different in winter and spring sorts. Both "volunteer" considerably in subsequent crops, but winter rye is probably the worst in this respect. Spring rye can be grown on some light soils where winter rye is not hardy. It is thus apparent that for much of the West, winter rye is the more important crop, although on light soils in some places spring rye may be found more suitable.

186. The Culture of Spring Rye.—Spring rye may be grown for hay or grain. On good soils it yields about the same as other cereals, but the quality of the hay is rather inferior to that of oats, barley or wheat. Its relative value is greatest on light sandy soils and in very dry areas. It can be sown as early as wheat, or as late as barley, since it is very hardy, and almost as early as barley. The seed should be tested and cleaned before seeding. The best varieties are Ottawa Select and Prolific, the former being a selection by the Dominion Cerealist and the latter an unnamed variety secured by the Field Husbandry Department at Saskatoon through a German farmer from Germany. One to one and one-half bushels is sufficient to sow. The grain should be cut before perfect maturity in order to lessen the loss by shattering. The curing and threshing processes are similar to those for other grains.

187. Advantages of Winter Rye.—The advantages that may be expected to result from the introduction of winter rye as an additional grain crop may be briefly summarized as follows:

1. It ripens much earlier than wheat and consequently is not subject to damage from early fall frosts.

2. A field of winter rye affords fall pasture and also the earliest green pasturage in the spring that can be provided by a grain crop in this country.

3. Owing to its early and rapid growth, winter rye chokes out many weeds. In view of this fact and also because it ripens between the middle of July and the tenth of August, or much earlier than barley, it is of particular value in combatting wild oats.

4. Summerfallow that is sown to rye in August or early September is less subject to soil drifting, either in the fall, winter or spring, than it is when a spring-sown grain, such as wheat, is used.

5. Ripening before other cereals it distributes the harvest season over a longer period of time and thus aids in lessening the labor shortage in the ordinary harvest season.

If sown early, winter rye may be pastured in the fall, but care should be exercised to see that it is not eaten off too closely, otherwise in a severe winter or on exposed elevations, the grain will be killed out. Unless stinkweed or other winter annual or biennial weeds are present, early spring pasturing, provided the top soil is dry, does not cause serious injury, but lessens the yield of the grain. If cut green winter rye makes very fair hay and generally yields as much per acre as the heaviest producing grain crops.

At the time of writing (June 1st) our winter rye averages 16 inches in height and is in the "shot blade", while our earliest wheat does not cover the ground, and is less than 5 inches long.

188. Some Objections to Winter Rye.—The chief objection to the use of winter rye in a wheat-growing district is in its "volunteering." Unless care is taken the rye seeds get distributed about the farm and grow up in other crops. A mixture of winter rye in wheat may result in lowering the grade. There need be no danger from this source, however, if cutting is not delayed too long and if reasonable care is taken to see that the threshed grain is prevented from being distributed about the farm.

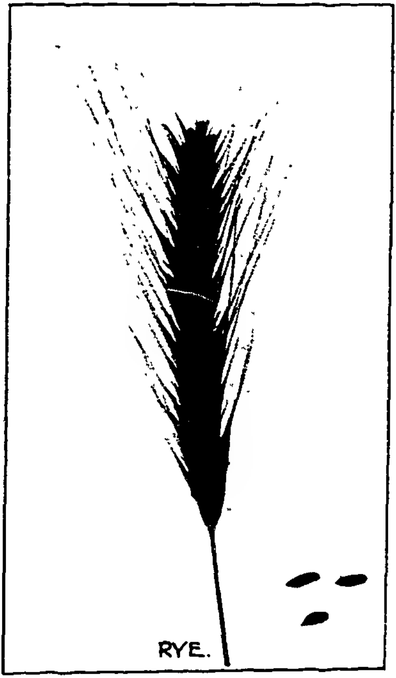

Fig. 74.—A Head of Rye.

The danger to a very early growing grain crop, such as winter rye, from late spring frosts is not great, but in some abnormally early seasons may be rather serious. In the spring of 1915 at Saskatoon winter rye started growth very early and was in the blossom stage when the last heavy spring frost came, the result being that the yield was decreased from a possible 40 bushels or more to less than 10 per acre.

When pastured by dairy cattle, winter rye sometimes taints the milk. This can be largely, if not wholly, overcome by pasturing the crop only immediately after milking and providing some other pasture during the latter part of the day.

In some areas and in some unfavorable seasons winter rye will kill out in patches. If under good cultural treatment the winter killing cannot be prevented, of course the crop will not be a satisfactory one to use. At Saskatoon it has killed out only once in six years, but at some other places it has killed out oftener.

The fruiting bodies of ergot in rye seed or straw are objectionable, since their presence in the feed of pregnant animals sometimes causes abortion. (See Sec. 195).

189. Uses of Winter Rye.—In Western Canada winter rye is grown chiefly (1) for late fall and early spring pasturage, (2) as a hay crop, (3) as a cleaning crop for wild oats and (4) as a grain crop on some types of soil that are inclined to drift.

For pasture it should be sown more thickly than for grain and may be sown any time after fallowing commences. The usual custom, however, is to sow in July or August in order to have pasture in the fall when the other pastures are dried up.

As a hay crop rye is inferior to oats, barley or wheat in quality, but in dry years and dry areas will produce more feed. Winter rye is frequently cut twice for hay in the same season, or once for hay and once for grain. This is a common practice in some of the dry areas where hay is scarce. The second crop, whether hay or grain is generally light except when the first one is cut very early.

When sown as a cleaning crop for wild oats winter rye gives good results if none of it kills out. By occupying the ground in early spring before the wild oats start it frequently prevents them developing.

As a grain crop it is less valuable than the other cereals where the latter can be satisfactorily grown. It is, however, our earliest ripening crop and always escapes fall frosts. The price is considerably less than wheat on the average. (Fig. 12). The yield is generally more, but in some places it averages less than wheat. In view of the fact that winter rye generally covers the ground in May, the month when soil drifting is most common, it is frequently used instead of spring grains on some of the soils that are subject to this form of erosion.

190. The Culture of Winter Rye.—To obtain the best results the seed bed should be in fine tilth, well compacted, and should contain a large amount of moisture. Summerfallow, plowed 6 to 8 inches deep early in June, harrowed immediately and well worked thereafter so that the soil is firm and the rainfall retained and all weeds kept down, makes an ideal seed bed for winter rye. The crop ripens early, so that damage from fall frost seldom occurs, while the early spring growth produces a stiff straw that seldom lodges. Rye should not be grown continuously on the same field, as this practice is reported to be favorable to the development of ergot. This fungus frequently attacks rye when sown in low, wet land or grown repeatedly on the same field. When the crops are properly rotated there is little danger from this disease.

In some places the fallow is considered too valuable to sow to winter rye. In others the crop kills out worse when sown on fallow than when sown on clean summer-

fallow stubble or on early shallow fall plowing. Under these or other conditions where stubble or fall plowing gives satisfactory results such a preparation has much to commend it. It is at least much cheaper.

191. Seeding Winter Rye.—Seed can be procured from any western seed house or from farmers who are already growing the crop. Care should be taken to procure home-grown seed, as the crop from imported seed will often winter kill. In Western Canada rye should be sown during the last few days of August or the early part of September so that it will have time to get well established before winter. (See Sec. 14). In the northern prairie section the earlier dates are to be preferred, but in southern Manitoba and southern Alberta later seeding sometimes proves the best. The seed should be sown with an ordinary grain drill at a depth of 2½ to 3 inches, so that it is certain to be down into the moisture. When sown on well prepared summerfallow, one bushel per acre is sufficient. Heavy seeding is apt to result in stunting the crop before the usual June rains come. It is perfectly safe to sow seed from a crop that has just been harvested. Late seeding or too thick seeding should be avoided. Ordinarily not less than three-quarters nor more than one and one-half bushels of seed should be used. Where pasturing is contemplated rather thicker seeding is desirable.

Should weed-infested land sown to rye show a new growth of weeds after the rye is sown, a stroke of the harrow should be given to prevent, if possible, biennial weeds entering the winter alive. Again in the spring the harrow may be used to advantage to break up the surface crust and kill any young weeds which may have started. If intended primarily for fall pasture the rye

should be sown in late July or early August. Spring pasturing of weedy fields is not advisable, as it gives the weeds a chance and makes the crop considerably later.

North Dakota No. 959 and Saskatchewan are the hardiest and therefore the best varieties to use.

192. Harvesting.—Under ordinary conditions winter rye is ready to cut by the first week in August of the year following that in which it is sown. In a dry year it may be ready somewhat earlier, probably between July 15th and 30th, depending upon location, tillage, rainfall, thickness of seeding, etc. It should be cut with a grain binder and handled exactly like wheat. The stooking should be done the day the rye is cut. Care must be taken to see that the grain is thoroughly dry when it is threshed, as rye tends to become musty more readily than wheat.

193. Marketing.—While there is always a good demand for rye on the Toronto and Montreal markets and in the larger cities of the United States, it is somewhat difficult to obtain satisfactory prices at local points. Under these circumstances, and owing to the fact that only a small amount is grown in the West and market facilities have not therefore developed, the best method of marketing is to ship in carload lots to some of the larger centres—Toronto, Minneapolis or Duluth. Owing to rye being duty free and the freight rate to Duluth the same as to Fort William, Duluth has been for the last few years the best market for Western grown rye.

194. Grades of Rye.—The definitions of the grades of rye as given in the Canada Grain Act are as follows:

No. 1 Canada Western rye shall be sound, plump and well cleaned.

No. 2 Canada Western rye shall be sound, reasonably clean, and reasonably free from other grain.

All rye which is from any cause unfit to be graded as No. 2 rye shall be graded as rejected.

No weight per measured bushel is specified for rye, but 56 pounds is the accepted weight in commerce.

195. Disease and Insect Enemies of Rye.—The insects affecting rye are, in general, the ones that affect wheat. (See Sec. 121 and Chap. XIV). Black rust, Orange and Stripe rust attack rye as well as wheat, and the preventive remedies are the same. Ergot is another disease of this crop. It cannot be controlled by treating the seed, but may be lessened by (1) thorough cleaning of the seed, (2) floating off the ergot bodies by using a solution of 40 lbs. common salt to 25 gallons of water, and (3) by growing the crop on fields that have not produced diseased rye the year or two preceding.

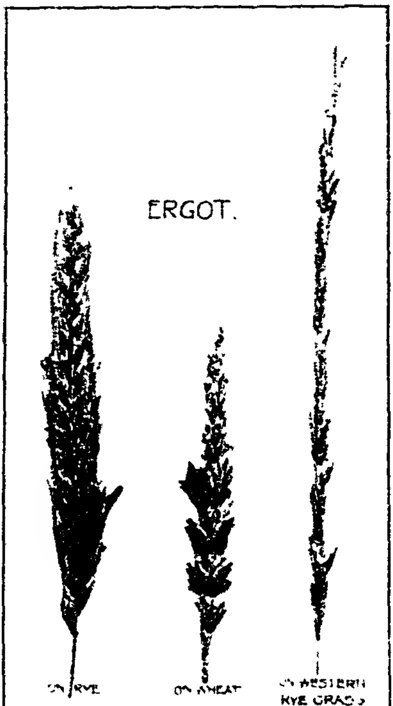

Fig. 75.—Ergot on Rye, Wheat and Western Rye Grass.

In some places a disease called Anthracnose causes the premature dying of portions of the head of rye, and sometimes attacks the

roots and lower portions of the stem. Treating the seed with formalin aids in preventing this disease.

Rye smut which is occasionally found on the leaves and stems may be lessened in subsequent crops by treating the seed with formalin as outlined for wheat in Sec. 9.

CHAPTER VIII.

FLAX

The Oil and Linen Plant.

The development of flax production in Western Canada, up to 1912, paralleled the breaking up of new land, particularly the heavy soils of southern and western Saskatchewan. The crop has been grown only for its seed, the threshed straw, up to the present at least, having been considered of little value either for its fiber or for feed. The crop is found to do best on new breaking or sod land. It is preferred as a first crop on many of the heavy soil types. It is perhaps the best cash crop to grow on breaking of the same season. The product is more cheaply marketed than any of the other grains, hence it has frequently been used as a "pioneer" crop on new land many miles from a shipping point. The maximum production was reached in Western Canada in 1912, since which time the acreage sown to flax has not kept pace with that of wheat, oats or barley.

196. History of Flax.—*The cultivation of flax and the manufacture of its fiber date back to a very remote period. The great value of this plant has been known and appreciated for probably five thousand years. The fact that the Egyptian mummies were wrapped in linen,

*Adapted from "The Flax Plant", Experimental Farm's Bulletin, No. 59, by Dr. Wm. Saunders.

shows that the use of the fiber of flax is very ancient. It was an old and well established industry in Egypt at the dawn of the Christian era. Some 3,000 years ago the Phoenicians devoted much attention to the cultivation of this plant, and subsequently the Greeks and Romans made the working of flax fiber a part of the household duties. Flax was brought to America by the early colonists, and the working of flax fiber was one of the earliest colonial industries.

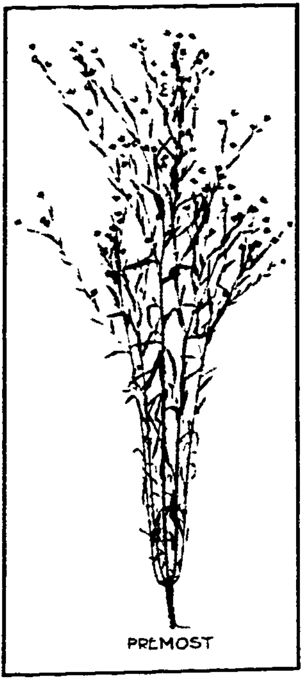

Fig. 76. A Well Developed Plant of Seed Flax.

The flax plant of commerce received from the great botanist, Linnaeus, the name of Linum usitatissimum. From the generic name Linum the words linen, lint, and linseed are derived, while the specific name usitatissimum, which means "most useful," was given to it in consideration of the service it had rendered the human family in supplying material for clothing.

197. The Flax Plant. — Unlike the crops already studied, flax is not a "cereal". It is, however, an annual plant having much the same period of growth, although rather more subject to injury from spring frosts than the grain crops. It usually grows 18" to 30" in height in this climate. The main stem branches just

above the ground when not sown thickly and these branches subdivide at the top into many smaller branches just before flowering. The flowers do not all develop at the same time and for this reason all the seeds seldom ripen at once. The flowers may be purplish blue in color, or white, or variations between these.

The seeds are usually ten in number in each "boll." They are oval in form and dark brown in color in most varieties. More than one-quarter of their weight is

Fig. 77.—Types of Flax.

made up of oil, while the outer covering is rich in mucilage. After the oil is pressed out of the ground up and heated flax seed (or dissolved out by naptha) the product left is linseed cake, which is largely used as a food for cattle (see table of composition in appendix).

The fiber, which constitutes the chief value of the crop in some countries, is found near the outside of the

stems. In the interior of the stem is the pith. A layer outside the pith is known as the woody zone, while outside the latter is the external layer in which the fiber is found. In some humid countries where the stems grow tall the plant is grown only for its fiber. For this purpose the seed is sown thickly in order to lessen the tendency to branch out. For seed growing drier areas are preferred and less seed is used.

198. Flax for Seed.—*"Flaxseed produces linseed oil, much used in the manufacture of paints, linoleums, and other important products; and, as a by-product, oil cake, used as a stock feed. Although much flaxseed is produced in the fiber-raising sections of Europe, the bulk of the world's crop is raised in regions of very different characteristics. Because of adaptability to varied climatic conditions, the seed crop has a much wider range than the fiber crop. Aside from Russia, the most important seed producing regions are North America, Argentina, and India, which have certain climatic characteristics in common, particularly high summer temperatures, and occasional droughts. Given a subsoil retentive of moisture, flax for seed thrives exceptionally well under extreme conditions of heat and drought.

"In the United States, Canada and Argentina, newly turned prairie sod is very commonly sown to flax before a crop of wheat is put on the land.

The cropping procedure in the seed-flax regions of Canada and the United States is similar. The crop is sown in the spring after all small spring grains are seeded. It is sown, cut, and threshed by processes differing but slightly from the similar processes for wheat.

* Sections 198 and 199 from "Geography of the World's Agriculture", by Finch and Baker.

The area of production in North America, centres in the spring wheat region in the States of Minnesota, North Dakota and Montana and in the Canadian Provinces of Manitoba, Saskatchewan and Alberta.

"In Argentina the flax is grown almost entirely in the Province of Buenos Aires, Entre Rios, Santa Fe, and Cordoba, on the lowlands bordering the Parana, between the wheat region to the West and the great sheep-raising estates in the east. In this region efficient railway transportation is an added advantage.

"The Indian flax crop is rather widely distributed, though the most important areas are found in the Central Provinces, in the United Provinces and in

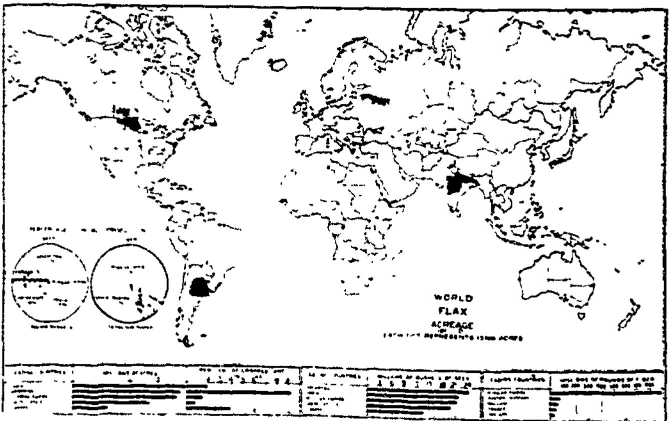

Fig. 78.—Distribution of the World Acreage of Flax.
By courtesy, Finch and Baker

Bengal. Much of the crop is grown in admixture with other oil crops such as rape, mustard and sesame. It is sown in October or November, grows during the dry season, and is harvested in March or April before the beginning of the monsoon rains. The cheap labor of

India does not encourage the use of the mechanical processes noted in connection with the flax regions of the New World.

"In dry southern Russia there is a considerable flax area devoted to seed production alone. The crop, which is declining in importance, is raised in part for oil and part to supply the demand for seed from the fiber growers of northern Russia, who believe they themselves cannot raise suitable seed. New lands in the Caucasus are generally used for this crop.

199. Flax for Fiber.—"Nearly all of the world's flax fiber comes from Europe, about four-fifths of it from Russia. The most important fiber-producing centres are northwestern Russia, the Netherlands, Belgium, northern France, and the north of Ireland.

"The climatic conditions of the flax-fiber regions are somewhat more uniform (than those of the flax seed regions). They are in general regions of high humidity, moderate rainfall, and rather cool and uniform summer temperatures. The crop normally is sown early in April, and late frosts sometimes do considerable damage to the young plants. The period of rapid growth is in June and July and bright, warm days with mild nights are then desirable. Showers are favorable at this time, but heavy rains are likely to cause lodging. If dew-retting is practised, as is the case in many localities, the most favorable climatic conditions are heavy dews and light rains with light frosts in the late fall. Such conditions are characteristic of the coast of Europe from Brittany to the Netherlands and to a less extent of the Russian flax region.

"The large amount of hand labor employed heretofore in flax-fiber production has prevented the development

of the industry in many sections of northeastern United States and the Pacific Northwest that are admirably suited to its production from the standpoint of soil and climate. The common practice in Europe is to pull the crop by hand, and then thresh it, commonly by hand, in order to save the entire length of fiber from the root to the branches. These are processes for which satisfactory mechanical devices are just coming into use in America.

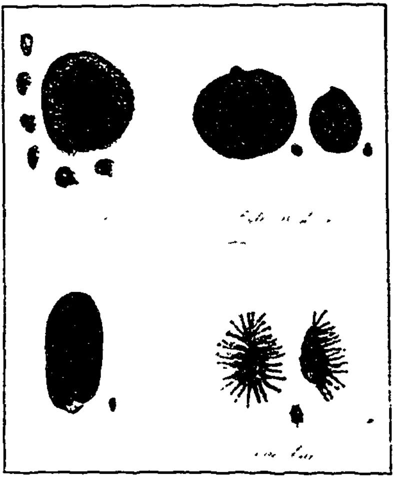

Fig. 79.—Weed Seeds Commonly Found in Seed Flax.
Rearranged after Clark and Fletcher

"About one-third of the world's supply of linen is spun in Ireland, to which centre much Russian and Belgian flax is exported."

200. Flax Seed Production in Western Canada. — Fig. 38 shows the development of flax seed production in the Western provinces. From this it will be seen that the crop has not been equally popular in all years. The wide fluctuations in price, the difficulty of securing seed that is free from weeds and the trouble in threshing flax that does not mature early and satisfactorily are the chief reasons for its spasmodic development.

The high prices of 1910 and 1911 (Fig. 40) caused a great increase in the acreage sown and when the prices fell in 1912 many growers revised their opinions of the

crop. There is no doubt but that the impurities introduced in flax seed have been chiefly responsible for the present weedy condition of many districts. The effect of flax on the land has been feared by many, but aside from the weed seeds and disease it may carry, flax has not been shown to be harder on the soil than any of our grain crops. This notion has developed where wilt and canker diseases have been introduced to the soil by diseased seed, and in other areas where poor crops followed flax, not because the flax hurt the land but because either the flax or the subsequent crops or both had been sown on ill prepared land.

201. The Choice of Varieties.—The most widely-sown and probably the best variety of flax for general use is Premost or Minnesota No. 25, a pedigree sort developed at the Minnesota Experiment Station. It is a blue blossomed, brown-seeded flax of the seed type. The best wilt resistant varieties are strains developed at North Dakota. N.D. No. 114, N.D. No. 52, N.D. No. 73 and N.D. No. 155 are good ones for flax-sick soils. Novelty is recommended by the Dominion Cerealist.

The fiber varieties are rather less productive of seed—usually yielding 25 to 30 per cent. less than the seed varieties. No fiber varieties have yet proven outstanding in seed production.

202. The Time to Sow Flax.—In general practice flax is sown later than the cereal crops. After it is a few days above ground it will stand considerable spring frost, but if injured it does not recover as satisfactorily as the cereals. If frozen to the ground or below the point at which the branches arise, it seldom recovers. In the fall it is rather hardier than the cereals, but if frozen before the plants are ripe it is very difficult to thresh. Between

the last killing frost in spring and the first in the fall the crop must be grown. Very large yields have occasionally been reported from seeding in April, and some fair returns have been obtained from sowing as late as the first week in June. On the other hand some seedings as late as the middle of May have been killed by spring frosts while most June seedings are generally damaged by fall frosts. In a series of tests over four years at Saskatoon the May 10th and May 20th seedings gave the largest yields. The best time to sow is, as a rule, towards the latter of these dates, although seeding during the fourth week of May is a common practice where flax is sown on spring breaking.

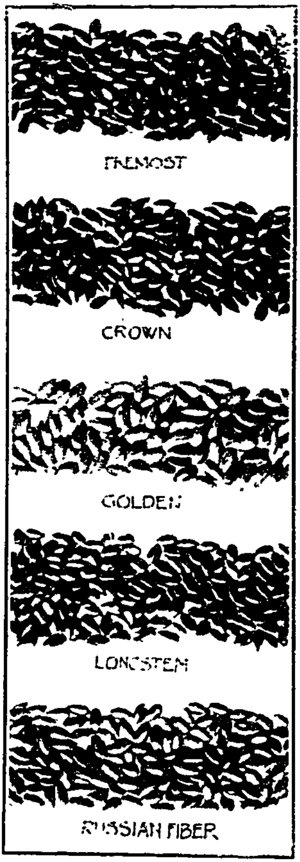

Fig. 80.—Seeds of Different Varieties of Flax

203. The Amount to Sow.—The amount of seed to sow per acre varies widely under different climatic conditions. When grown for seed in this climate a half bushel (28 pounds) is commonly used, although as little as 20 pounds and as much as forty pounds is sometimes sown. In the fiber districts of

Belgium and Ireland where single unbranched stems are desired. 2 bushels or more is frequently used. Thick seeding in our drier climate results in earlier maturity, but also in a shorter straw, which is frequently a serious fault in the drier areas.

At Saskatoon, when sown on well prepared loam soil in good season with a press drill, 20 pounds per acre, has given a higher average yield than any thicker seeding. The amount recommended for general use is 25 to 30 pounds. At Indian Head thicker seeding—40 to 50 pounds is reported to have given best results.

204. The Depth to Sow Flax.—The seed of flax is much smaller than that of the cereals, hence should not be sown so deeply. The soil for flax must be firm and the moisture near the surface so that shallow seeding will place the seed into the moist soil. From 1 to 1½ inches below the surface is generally the best depth to sow.

205. The Preparation of the Seed.—As with the seeds of cereals, flax seed should be tested for germination, cleaned and treated with formalin before being sown. Germination is frequently injured by frost, weathering or heating, and the extent of the injury can only be determined by a germination test. (Sec. 8).

The most serious fault at present in flax seed is the large number of weed seeds it is likely to contain. Blue burr, false flax, ball mustard, hare's ear mustard and many other weeds are frequently found in flax seed. The four kinds mentioned cannot be entirely removed by cleaning but many of them can be taken out, and most other kinds can be entirely removed. In addition to the weed seeds and foreign matter present, many dead, injured and diseased seeds may also be removed.

Thorough cleaning is more necessary with flax than with any of the grain crops.

The diseases so common to flax in older agricultural regions are as yet not so prevalent in Western Canada, but they are already in some of our soils and in some degree in much of our seed. Thorough cleaning and grading is one means of aiding in their control.

206. Flax Diseases.—The most common diseases of flax are popularly known as flax wilt and flax canker. The former results in the "wilting" and death of the flax plants shortly after they appear above ground. Canker does not destroy the plant until after the bolls

Fig. 81.—Flax Canker or the Breaking Over Disease of Flax.

form. The root at the surface of the ground is then found to be constricted and weakened and the plants break over. In some places the disease is spoken of as the "break over" disease.

Both wilt and canker are fungous diseases that are carried by the seed, and that live in the land for some years after infected seed has been used. Canker is not so well understood but is reported to be most injurious on the lighter soil types and drier areas while wilt does greater damage on the heavier, richer and more moist soils*

These diseases are controlled by (1) using seed that is known to be relatively free from disease, (2) thoroughly grading the seed to remove scaly or shrunken seeds which are likely to be diseased, (3) treating the seed with formalin (Sec. 9), (4) sowing only on land that has not grown flax for several years, and (5) selecting the seed for sowing from a crop that has been saved without serious weathering.

207. Soils for Flax.—Under the climatic conditions of the Canadian West the soils that have been found best for flax are the heavy types. Light soils are seldom sown to this crop, and while the medium types of heavy loams are sometimes used, the crop is seldom regularly grown on them. Flax is chiefly grown on the heavy clays of the Regina plains and Goose Lake district of Saskatchewan, and on the medium heavy types in other portions of the prairie area of all three provinces. It is seldom grown in the park belt or in the more humid parts of the prairie belt.

208. Place of Flax in the Cropping System.—On the heavy soil types, flax is often the first crop after breaking. Once the new land is all under cultivation the crop is either discarded or used as the second or third crop in the rotation. When grasses are grown on heavy

* Bolley and Wilson in North Dakota Circular No. 1, "Flax Cropping and Harvesting Methods".

soils flax frequently follows the grass. In the "loose top" and in some other soils wire worms attack the cereals sown on grass land, hence flax is frequently used on such fields. It is seldom grown on fallowed land, since in wet and backward seasons, particularly in the north, it may not mature satisfactorily. On warm soils in the south this objection is not a serious one.

209. Preparation of Land for Flax.—Flax is usually sown (1) on breaking done the previous season, (2) on breaking done the same season, or (3) as a second or third crop after fallowing.

When sown on breaking done the year before, the land should be treated in essentially the same way as for wheat. The surface mulch, however, should not be as deep as for wheat. Flax requires a firm seed bed. It germinates less satisfactorily in a poor, dry soil and suffers much more from a loose, drifting surface than any of the cereals.

Sowing flax on breaking of the same season is a common practice although a risky one, particularly in the drier parts and in the areas of short growing season. In unfavorable years many crops so put in are found to be not worth harvesting as a result of drought in early summer or injury from fall frosts owing to late seeding or late germination. Where this plan is followed the breaking is usually done as carefully as possible 3 or 4 inches deep during the second or third weeks of May and the land packed or planked and seeded as soon after the land is plowed as possible. On some types and conditions of soil the land is often disced and harrowed before seeding and packed afterwards. This additional work usually increases the returns on soils that work up easily, but it is not a general practice, particularly in

the drier parts, possibly because the whole method is a gamble and the less expense one puts into it the less one will lose. In the more humid prairie areas the prospect of success is greater and the extra tillage work is therefore more often given.

If the flax is to be sown on old land, fall or spring plowing is preferred. The latter frequently gives better results in the drier districts if done in good time and the seed sown immediately after the plowing. When sown on fall or spring plowing the seed should either be sown with a press drill or the land should be packed afterwards. On clean stubble fields that are free from grass and weeds, flax is sometimes sown in the stubble of the fallow crop. This practice has all the disadvantages and but few of the advantages of sowing wheat under the same conditions. It should never be followed except on clean land in a good state of tilth.

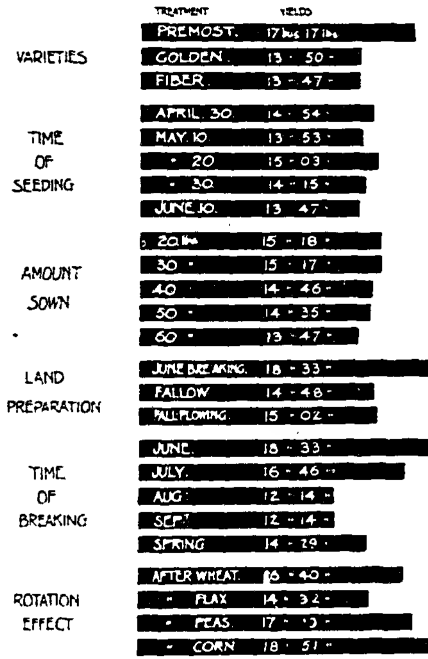

Fig. 82.—The Culture of Flax for Seed. Summary of four years' tests at Saskatoon

210. Harvesting the Crop.—Flax harvesting should generally be delayed until the crop is as ripe and dry as possible. Green or immature flax requires a longer time

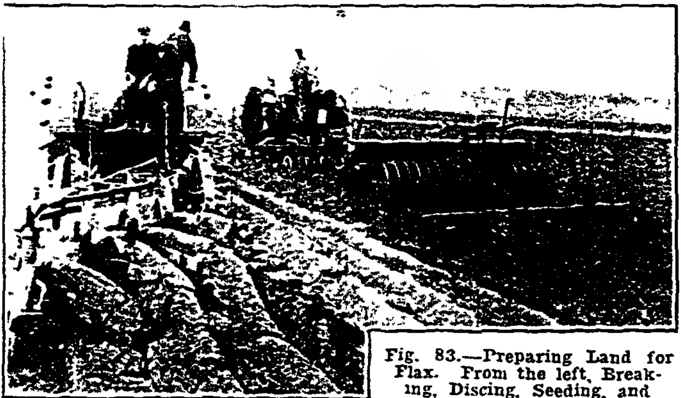

Fig. 83.—Preparing Land for Flax. From the left, Breaking, Discing, Seeding, and Harrowing.

to cure and always gives more trouble in threshing than a ripe crop. Owing to its long blooming period flax often contains many immature bolls which may develop if the crop is left uncut for a time after the first bolls are ripe. As the fall advances it may become advisable to cut before perfect maturity as otherwise the threshing may be delayed until the short, cold and damp days of the late autumn season, when neither curing nor threshing proceeds satisfactorily.

The cutting is generally done with a grain binder. Some growers tie the flax into sheaves and stook it up, others drop it from the bundle carrier in small, untied bunches, while still others remove the binding attachment and let the flax fall out in a continuous windrow. In the two latter cases it remains on the ground unstooked till threshing time. Tying into sheaves is ad-

visable if the crop is ripe and quite dry, but large sheaves of green flax do not dry out satisfactorily and therefore give trouble in threshing. Dropping in loose bundles is the cheapest method and is satisfactory in dry autumns, but in wet ones trouble is experienced in getting the bundles dry enough to thresh well. The continuous windrow method requires more labor at threshing time and usually results in greater waste. The untied bundle method is generally followed but a few more careful farmers tie the sheaves and stook them.

211. Threshing.—*"Flax is usually considered a hard grain to thresh, although dry, well cured flax does not necessarily thresh hard nor give trouble. No attempt should be made to thresh damp or tough flax. The grain which comes from such damp straw can hardly be saved without considerable loss, unless much care is taken to dry the seed after it is threshed and this is an expensive process.

"Particular care should be directed to the speed of the separator, the work of the cylinder and the sieves. There should be no end-play in the cylinder. End-play there causes cracking or chipping the seed. The loss in dockage due to cracking, is often 10 to 15 per cent., and cracked or partially cracked seed is often greatly injured for use as seed. The separator should not be run at too high speed. There should be only enough teeth in the concaves to knock out the seed. It is essential to avoid breaking up the straw as much as possible since large masses of shives, leaves and chaff clog the concaves and interfere with the work of the sieves. They do not pass over the chaffer but drop through onto the sieves. These

* From "Flax Cropping and Harvesting Methods", North Dakota Circular No. 1, by Bolley and Wilson.

become over-worked and much seed goes over with the chaff or is thrown into the return elevator and receives a further cracking and injury. With a twelve bar cylinder, the speed should be approximately 980 to 1,000 revolutions per minute. Most separators are now equipped with the adjustable seive. In case this is used a regular flax screen should be placed under it."

212. Precautions in Shipping Flax.—When shipping flax special care should be taken to see that all cracks or leaks in the car are properly repaired. Flax flows more readily and through much smaller openings than any of the other grains, hence this precaution. It is a common practice to line cars with heavy building paper before shipping if there is any doubt about their freedom from leaks.

213. Grades of Flax.—The following are the legal grades of flax in Canada:

No. 1 Northwestern Canada flax seed shall be mature, sound, dry and sweet, and contain not more than twelve and a half per cent. of damaged seed and weigh not less than 51 pounds to the bushel of commercially pure seed.

No. 2 Canada Western flax seed shall be mature, sound, dry and sweet, and contain not more than twenty-five per cent. of damaged seed, and weigh not less than 50 pounds to the bushel of commercially pure seed.

No. 3 Canada Western flax seed shall be flax seed which is immature or musty, or which contains more than twenty-five per cent. damaged seed, and is fit for warehousing, and testing not less than 47 pounds to the bushel of commercially pure seed.

Flax seed that is damp, warm, mouldy, musty or otherwise unfit for warehousing, shall be classed as no grade.

To test flax seed, one pound of average seed shall be taken from the sample tested, and the impurities or foreign matter therein shall be removed as near as possible by the use of two sieves of 32-gauge wire-cloth, one with meshes 3 x 16 and the other with meshes 16 x 16 to the square inch. The percentage of impurities and weight per bushel of the commercially pure seed shall be determined by the use of proper testing scales.

214. Flax Straw and its Uses.—Flax straw has not been regularly utilized in the West. Animals are usually allowed to run about the stacks in winter and often do well where other feed is provided in addition. Generally no attempt to utilize this by-product efficiently is made. Bolley, in a summary of the statements made by seventy farmers in North Dakota who had fed flax straw which had been frosted while green, states:

"Regardless of care in threshing there is apt to be much light seed and light weight chaff materials in every straw stack, and cattle always seem to thrive when running to such stacks, providing they have sufficient other feed. This is probably due to the beneficial effects of the seed.

"Green flax straw should be fed sparingly at first. After the cattle get used to it there seems to be slight danger. When feeding the straw at the barn it is best to feed it only once a day, and that at night, using hay for the other feedings.

"A too sudden change to a heavy diet of flax screenings or flax straw may cause "scours" and possibly kidney trouble, which tends to make the animals very weak, particularly in the hindquarters. Two or three spoke of this trouble as somewhat similar to "staggers". This may be remedied by changing the diet back to hay or other regular feed.

"Many farmers mentioned that they had heard that feeding too much such material tended to cause abortion, but only one reported such a case. This was in a flock of sheep which had been fed flax straw. In the spring a larger percentage than usual aborted.

"Two instances were noted in which death occurred from over-eating flax screenings, which, in connection

with filling up on water, caused bloating and death. Two cases were noted where horses died from eating the straw. Autopsy showed that their stomachs were clogged with fiber masses. In one of these cases it was found that the horse did not have water enough." (See also sec. 294).

Other possible uses for flax straw are for low grade fiber materials, insulation material, and paper. The utilization of this by-product is now being studied in different places, and there is some hope that instead of being a waste as it is at present, it may become a profitable sideline in the production of seed flax.

CHAPTER IX.

FIELD PEAS

The Crop of Quality.

The chief leguminous plants that are grown for their seeds are the soy bean of the Orient, the cow pea of the Southern States and the field and garden peas of more northern climates. The soy bean and cow pea are warm climate crops and do not mature satisfactorily in our short growing season. The field pea is better suited to culture under field conditions in Western Canada than any other annual legume grown for its seed. It has been called the crop of quality on account of its high protein content. (Fig. 185).

215. Distribution of Peas in Canada.—The area in which peas can be profitably grown for seed is limited on the south by the high summer temperatures, on the north by the short growing season and in parts of the east by the presence of the pea weevil. In the United States the acreage is largely concentrated in north eastern Wisconsin and Michigan, although a limited acreage is sown to peas in Washington and Oregon and the northern New England States.

In Canada, Ontario produces about six times as much field peas as all the other provinces put together, and ten times as much as the three *Prairie* Provinces. In re-

cent years the acreage in Ontario has decreased owing to several unfavorable years, the ravages of the pea weevil and the increasing cost of labor.

In Western Canada the average acreage in the years 1910 to 1916 inclusive was nearly 8,000 in Manitoba, 15,000 in Saskatchewan, and 8,000 in Alberta. These figures do not include the amount sown with oats or other cereals for hay, the acreage of which is not known but is thought to be very much greater than that on which peas were sown alone. The areas where peas have done best are the park belt and the more humid prairie areas. Further north the frost danger limits the acreage sown for seed while in the drier parts peas do not produce well. As mixed forage, peas and oats are grown satisfactorily as far north as settlement has gone.

216. Uses of Peas.—The chief uses to which the pea crop is put in Western Canada in the order of their present importance are: (1) as forage for stock in the form of hay, pasture or silage, (2) as grain for stock food, (3) as human food and (4) as a soil improver.

217. Peas as a Hay Crop.—Chiefly in the dairy sections of the West but also in many other parts a mixture of peas and oats cut green for hay furnishes a large part of the winter feed. The peas add protein to the feed and the upstanding oats facilitate the harvest by permitting the use of a binder instead of the more laborious process of "pulling" or mowing where the peas are grown alone. The hay from peas and oats is highly valued for dairy cattle and also for other classes of stock, particularly growing animals.

In discussing the general question of legume forage plants of which peas is one, Henry and Morrison state:

*"The cereal grains and the grasses are all rich in carbohydrates compared with crude protein, and thus serve primarily as sources of energy and fat in nourishing animals. The legumes comprise the great group of food-bearing plants characterized by their high content of crude protein, and therefore serve especially for building the muscles and other protein tissues of the

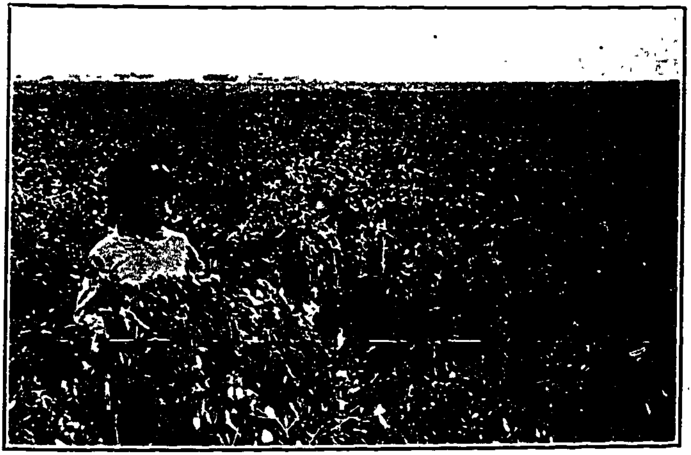

Fig 84.—Field Peas.

body. Their great value is due not only to this but also to their richness in lime, which is required in large amounts by growing animals and those which are pregnant or giving milk.

"The leguminous roughages are therefore admirable supplements to the cereal grains, and stand in marked contrast to forage from corn, the sorghums, and the smaller grasses, all of which, if cut when nearly mature,

* From "Feeds and Feeding", Sixteenth Edition, by Henry & Morrison.

furnish forage low in crude protein and only poor to fair in lime. Through the proper utilization of roughage from the legumes the amount of concentrates needed to provide balanced rations for farm animals may be greatly reduced. Indeed for many classes of animals merely legume hay and grain from the cereals furnish a most satisfactory combination."

218. Field Peas with Oats for Silage.—This subject has been studied more at the Lacombe Experimental Farm than anywhere else in Canada and the following summary of the Superintendent, Mr. G. H. Hutton, is therefore of value. He writes: "In central Alberta the growing of corn for silage is not feasible for the reason that only in fifty per cent. of the years in which corn has been grown has the crop reached sufficient volume to be considered profitable. The best substitute for corn is peas and oats, seeded at the rate of one bushel of peas and two of oats to the acre. In fact our experience with these two fodders, as grown under central Alberta conditions, indicates that peas and oats are superior for silage purposes to corn, but since the former is dependable every year, and the yield satisfactory, it is safe to predict that it will occupy a premier position among silage crops for this section of the West.

"Peas and oats, or peas alone, can be sown for silage purposes as soon as the crop intended for threshing has been seeded, and the crop will be ready for putting into the silo when the oats are in the late milk or early dough stage, before the crop intended for threshing is ready for the binder.

"Experiments which have included the whole dairy herd at the Lacombe Experimental Station have been

carried on during the past two years to determine the relative feeding value of this silage as compared with the same feed cured in the ordinary way in the shock as green feed. In both years the results were decidedly in favor of ensiling the crop, showing a saving in the cost of producing a pound of butter of as much as four cents; and a saving of as much as seven cents per pound with silage made from peas and oats as compared with silage made from corn."

219. Peas as a Pasture Crop.—What has been said of peas for hay applies also to peas as a pasture crop. The high cost of the seed lessens its use as a pasture crop except in mixtures for milking cows or for young pigs. Where annual pasture is grown for either of these classes of stock peas in a mixture with cereal grain is worthy of trial.

The practice of fattening hogs by turning them into a matured crop of mixed peas and barley seems a wasteful one and is seldom followed in Canada, yet it has been found quite profitable in some parts of California and Oregon and is well worthy of trial on ranches in those parts where peas do well and where labor is high-priced.

220. Peas as a Grain for Stock Food.—Protein is the most valuable of feeding constituents and food stuffs carrying it are correspondingly high in price. The field pea contains twice as much crude protein as the cereals and is also rich in phosphorus and potassium. As part of the grain ration for growing animals of any class or for fattening cattle, sheep or swine, peas may be used to very great advantage. On account of the hardness of the seed, peas should be ground before being fed, and because of the heavy, soggy texture of the meal, as well as its high protein content, it should be mixed with the

lighter feeds, such as oats or barley, which are at once lighter in texture and much lower in protein. In mixtures with corn and bran, peas may also be profitably used.

221. Field Peas as Human Food.—Since peas contain more nitrogeneous materials than any of our other home-grown vegetable foods, they may be used as beans are used to replace a part of the meat ration. They are rather less tender and less palatable than the garden

Fig. 85.—Bunches of Four Good Varieties of Peas.

varieties but may be utilized either as split peas in soups or as canned green peas. The Arthur variety is one of the best for this purpose.

222. Peas as a Soil Improver.—As a green manure crop peas is sometimes grown, but the cost of the seed has prevented its extensive use for this purpose. The plowing under of green peas, like plowing under any other

leguminous crop, adds not only organic matter, but also nitrogen to the soil. In the latter respect it is superior to any non-leguminous crop for this purpose. The acre cost of the seed is, however, so much greater than the acre cost of red or sweet clover seed—and these crops can be used for the same purpose—that the use of peas for green manuring is not likely to prove profitable. It has, however, a very favorable effect on the land, even if the crop is removed.

As a preparatory crop for wheat, oats and barley, the value of peas as compared with wheat and flax is shown in the following table, which summarizes three years' work as Saskatoon:

			Average Yield (3 Years)
Wheat	after	wheat	20 bus. 51 lbs.
"	"	flax	23 bus. 22 lbs.
"	"	peas	28 bus. 30 lbs.
Oats	after	wheat	64 bus. 24 lbs.
"	"	flax	62 bus. 18 lbs.
"	"	peas	68 bus. 21 lbs.
Barley	after	wheat	35 bus. 47 lbs.
"	"	flax	38 bus. 22 lbs.
"	"	peas	41 bus. 12 lbs.

223. Objections to Growing Peas in the West.—The chief difficulties met with in growing peas in the West are (1) the danger from fall and spring frosts, (2) the low yield in dry years and dry areas, and (3) the labor cost of harvesting and curing.

Peas like a cool, moist growing season and this is approached only in the eastern prairie belt, in the lower foothill region, and in the park and wooded areas. Except in southern Manitoba this belt is in the region of rather early fall frosts and as peas require as long to mature as wheat there is some danger from low

temperatures. In the drier parts of Southern Alberta and Saskatchewan the high temperatures often cut down the yield. In spite of these difficulties, however, as much as 50 bushels per acre has been produced in favorable seasons in different parts of the plains. On the other hand, as little as 10 bushels per acre was grown at Saskatoon in the dry year of 1917.

The labor difficulty is the chief cause of the low acreage in peas. This may be partly overcome by growing peas and oats together. In years when there is plenty of moisture and no serious spring frosts, equal weights of peas and oats can be sown together for grain or hay with quite satisfactory results. If, however, this mixed crop gets a setback the oats usually recover first and develop at the expense of the peas. In those areas where heavy frosts occur late in the spring, or where prolonged drought in spring is frequent, more peas and less oats should be sown per acre.

224. The Choice of Varieties. — The variety most highly recommended by the Dominion Cerealist for all three Prairie Provinces is Arthur, a medium early white pea. Other varieties considered good by the Dominion Experimental Farms are Golden Vine, Chancellor, English Gray and Prussian Blue.

At Saskatoon a medium early New Zealand variety called Carleton has given the largest yield with Mash, a rather late Swedish variety, second, Early White third, and Arthur fourth in yield. Empire is a less productive but very early sort. Early White is considered a very promising variety for Saskatchewan conditions.

225. Brief Descriptions of Varieties.—

Arthur.—This is a medium early, white flowered variety. The vines are large and the seeds large and

cream-colored. Other varieties of similar habit and appearance are Canadian Beauty and White Marrowfat. This is the most popular of the large seeded peas.

Golden Vine.—This has been the most widely-grown variety up to recent years. It is a smaller seeded sort

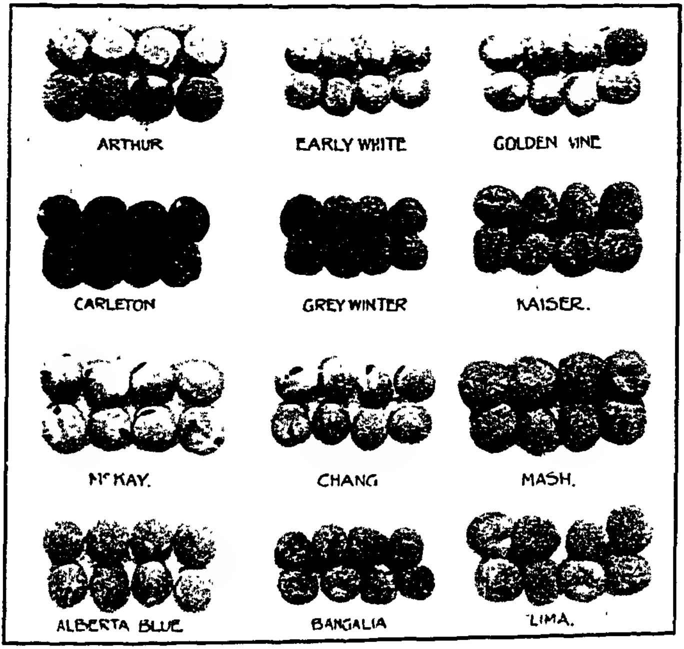

Fig. 86.—Seeds of Different Varieties of Peas.
Showing characteristic differences in size, shape and color markings.

having white flowers and white seeds. It ripens two or three days later than Arthur and generally yields somewhat less. The vines are rather finer than those of Arthur. Its popularity has been due not only to the fair yields it produces, but also to the fact that it requires

less seed per acre and the seed is usually easily obtainable.

Carleton.—This variety has recently been introduced by the United States Department of Agriculture from New Zealand. The seeds are of medium size and are marbled brown in color. The vines are small to medium in size and in height and the blossoms are colored. It has been the heaviest yielding variety at Saskatoon.

Early White.—This is a mass selected strain out of an unnamed variety secured from Mr. F. J. Dash, of Hillesden, Saskatchewan, by the Field Husbandry Department of Saskatchewan University. It is six or seven days earlier than Arthur, the seeds are very small, the flowers white, and the vines medium in size. It is not considered as good a cooking variety as Arthur but, on account of its small seeds and early maturity, is recommended for stock purposes.

Prussian Blue.—This variety has white flowers, medium sized, round bluish green seed and rather large vines. It matures slightly later than Arthur. Wisconsin Blue is quite similar in character.

Alberta Blue.—This is a white blossomed, blue seeded sort which ripens very early and yields fairly well. It is small to medium in size and is spoken of very highly by Dean Howes of the Alberta College of Agriculture for central Alberta conditions.

Empire.—A small growing, white flowered sort having green medium-sized seeds. It is the earliest variety ever tested at Saskatoon, but a low yielder. It was first obtained by the Field Husbandry Department at Saskatoon from Mr. W. E. Lake, of Edam, Saskatchewan, who obtained it with other samples of prize-winning

seed from the International Soil Products Exposition at Tulsa, Oklahoma, in 1913.

The other varieties, seeds of which are represented in the illustrations have not yet been tested sufficiently long to warrant recommending them, hence space will not be taken to describe them here.

226. Place in the Rotation.—Where peas are grown alone in the prairie area they should be planted on fallow or after corn or on sod land. It is important that they be sown on land that is free from weeds and well supplied with moisture. In the more humid parts peas may be sown on fall or spring plowing after cereal crops with more prospect of success. If grown for hay in mixture with grain, fall or spring plowed stubble may be used, but lighter returns should be expected than from fallow, sod land or corn ground.

227. Soils for Peas.—In this climate the condition of the soil with respect to moisture is more important than the soil type. Ordinarily, however, peas do best on the medium to heavy types of soil. Heavy loam soils that hold the moisture well, and that do not blow or bake, and are rich in organic matter are preferred to all others.

228. Preparation of the Land.—As has been pointed out, the best preparation in the drier prairie areas is either a fallow, corn ground or sod ground, broken the previous year, while in the eastern prairie areas and northern parts fall or spring plowing may be used. Whatever the immediate preparation it is desirable that the soil (1) have plenty of stored moisture, (2) be reasonably free from weeds, and (3) that the seed bed be well prepared and firm. Peas require much moisture, they cannot be depended upon to crowd out weeds, and

the germination is so slow under unfavorable conditions that a firm, moist seed bed is important.

229. Preparation of the Seed.—The germination of the seed may be low as a result of frost or weathering or hardening of the seed coat. It is therefore desirable to test the germination. Cleaning is also necessary to remove split peas and impurities. Since the pea weevil is not found here it is not necessary to treat with carbon bisulphide, as in the east. Nor is it necessary to treat with formalin. Some minor fungus diseases might be lessened in this way but the treatment has not yet been shown to be necessary.

Inoculation of the seed with a culture of the bacteria which live on the roots of peas and which have the power of taking free nitrogen from the air, usually increases the yield. The crop will grow in the absence of these bacteria but not with as good results either to the crop or to the land as when they they are present. The inoculation can be effected by treating the seed with a pure culture of the pea bacteria or by scattering some inoculated soil on the field at the time it is being prepared for seeding. About 200 lbs. per acre of such soil is sufficient. The land should be harrowed immediately in order to prevent the sunlight killing the bacteria in the soil distributed. (See Secs. 258 and 267.)

230. The Time to Sow Peas.—Peas will stand considerable frost, but if severely injured by a heavy spring frost they recover slowly, thus giving weeds an opportunity to develop.

In the Northern States seeding in late April and early May is common. In the Prairie Provinces the last few days of April and the first ten days of May is recommended. At Saskatoon the largest average yield in a

four-years' trial was from the seeding made on April 30th. There is occasionally severe damage from frost to peas sown this early, but there is also danger in the fall if the seeding is delayed too long. (14).

231. The Amount to Sow.—The amount to sow varies from $1\frac{1}{2}$ to $3\frac{1}{4}$ bus. per acre, depending upon

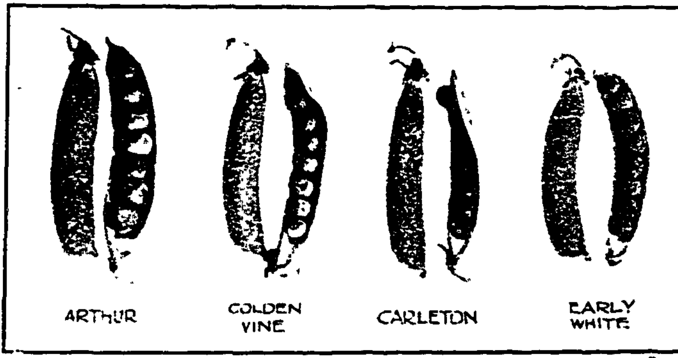

Fig. 87.—Pods of Peas.

the size of the seed and the moisture supply. In the small seeded sorts such as Golden Vine, French June and Bangalia there are about 3,000 to 3,500 seeds per pound, while in the larger seeded kinds like Arthur, Solo and Mash there are only 1,500 to 1,800. It is therefore apparent that more seed of the latter must be used if a good stand is to be secured. In moist regions or on soil well stored with moisture thicker seeding is also advisable. At Saskatoon the amounts recommended are 2 bus. of the small seeded sorts, $2\frac{1}{2}$ of the medium-sized and 3 bus. of the large seeded sorts. In drier areas $\frac{1}{4}$ bus. less might well be used, while in more humid parts $\frac{1}{4}$ bus. more might with advantage be sown. (15).

In mixtures of peas and oats equal weights or 1 bus. of peas and 2 of oats are commonly recommended. In dry areas or when spring frosts are prevalent, more peas and less oats should be used, since under both these conditions the oats start sooner than the peas and thus often seriously interfere with the growth of the latter.

232. Seeding.—In seeding peas in a dry climate, drilling is the only reliable method. The seed should be sown well into the moisture and the soil well harrowed or packed afterwards. Broadcasting and harrowing in or plowing under are too precarious for this climate.

233. Harvesting Peas.—Owing to the procumbent habit of the crop and also to the fact that peas shell readily when ripe, they cannot be cut with the ordinary binder when sown alone. Small lots may be "pulled" or cut with a scythe, but mowers with pea lifter attachments are best for large areas. These attachments consist of long guards which are fastened to the cutter bar, and which lift the low-lying vines so that they may be cut close to the ground. In order to prevent shelling it is advisable to have another attachment on the mower designed to remove the peas from the path of the machine before its next round. Otherwise a man must follow and take the peas out of the way to prevent the horses and mower from tramping and shelling those already cut.

Less loss from shelling will result if peas are cut in the morning or on a cloudy day rather than a hot, sunshiny day. They may be cut as soon as all the pods are ripe. After cutting they should be put up in bundles until ready to be hauled to the stack or thresher. In this country there is great danger of the bundles blowing around in heavy winds. To offset this the peas are

sometimes left uncut until dead ripe and then cut and either threshed or stacked at once. The only other alternative is to leave them in bundles in the field. This is quite satisfactory in the wooded areas but not in the open plains where high winds may roll bunches about and cause serious loss by shattering. Should a wet period intervene after the crop is cut, the bundles should be turned as soon as the upper side is dry in order to prevent the peas next to the ground from spoiling. If the crop is stacked, the stack should be "topped off" with hay or some other material that will shed rain, as the peas themselves are so light and loose that they are useless for this purpose.

Where peas are being grown merely for hog feed some farmers turn the hogs on the field in the fall and let them harvest the crop. This does away with all the difficulties and high cost of harvesting and threshing, and pigs make excellent gains in this manner.

234. Threshing.—*"The threshing of the field pea is usually done with an ordinary grain separator fitted up especially for peas by the substitution of blank concaves, leaving only one row of concave teeth below the cylinder. Usually four concave teeth are sufficient to retard the passage of the vines long enough so that the cylinder will break up the pods and release the seeds. By thus limiting the number of concave teeth and greatly reducing the speed of the cylinder it is possible to thresh the field pea without cracking much of the seed. In regions where the field pea is largely grown, the threshing machine is commonly equipped with an adjustable pulley, thus making this pulley large enough to decrease

* From United States Department of Agriculture Bulletin No. 690 on Field Peas.

the speed of the cylinder to the required number of revolutions. Where the peas are intended only for feeding purposes such precautions are not necessary, since cracked seed is then not objectionable. Where the peas are to be sold for seed purposes, however, great care should be used in threshing, and the peas should be run through a fanning mill after coming from the machine, in order to remove the remainder of the cracked seed."

235. Grading of Peas.—The offering of peas on the Winnipeg market has been so small that no official grades for the Western Inspection Division have been made. The grades for the Eastern Inspection Division are as follows:

No. 1 peas shall be white, clean, sound, not worm-eaten, and free from bugs, and shall weigh not less than 64 pounds to the bushel.

No. 2 peas shall be reasonably clean and sound, and reasonably free from worm-eaten and buggy peas, and shall weigh not less than 62 pounds to the bushel.

No. 3 peas shall be such as are too dirty to be graded No. 2 or are worm-eaten or buggy, and shall weigh not less than 60 pounds to the bushel.

The grades of 1, 2 and 3 marrowfat peas shall correspond in all respects with the preceding grades Nos. 1, 2 and 3 except that the former shall be of the white-eyed and black-eyed varieties.

Mixed peas shall be sound and may contain a variety of peas not elsewhere classified.

CHAPTER X.

FORAGE CROPS

The Crops of Permanence.

In this age and under the economic conditions now existing, the world's agriculture naturally falls into three general but distinct types:

(a) The Oriental type, which is productive and permanent and yet almost devoid of live stock.

(b) The European type, which in its better form is productive and permanent and includes live stock.

(c) The Western type, which is sometimes productive but not permanent and which in most pioneer regions includes little live stock.

236. Why the Oriental Type of Agriculture is Productive.—The Oriental type is productive because the inhabitants feed the soil. It is permanent because they return organic matter and as much of the important plant food elements to the land as they take from it. They have practically no live stock other than human beings and poultry, but all the excrement and crop residues and some little additional plant food and much organic matter is returned to the land. The experience of 4000 years of continued cropping has taught these people the art of farming, and of maintaining permanently the fertility of the soil.

237. Why the European Type of Agriculture is Productive.—The European type is very different in method from the Oriental yet in substance it is the same. Population has not increased to the point where vegetable

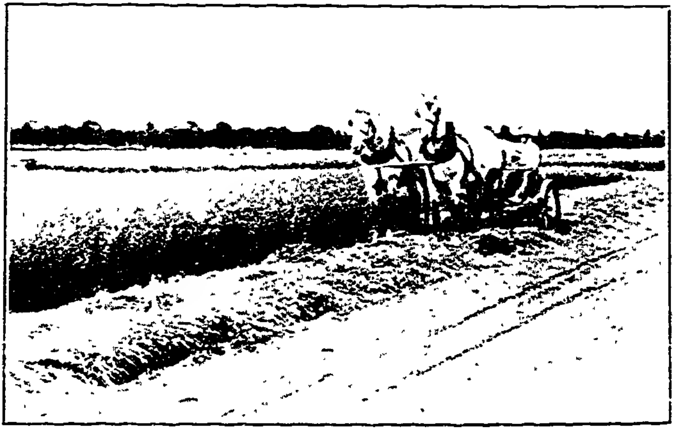

Fig 88.—Cutting Western Rye Grass and Alfalfa at Brandon.
By courtesy Dominion Experimental Farms

foods are too expensive to feed to animals, hence live stock is used to a considerable extent and the manure carefully preserved and returned to the soil. To make up for the difference between the amount of plant food removed from the soil and that in the manure returned to it, commercial fertilizers are applied and leguminous crops grown. In both Oriental and European agriculture the maintenance of tilth is provided for by keeping up the organic matter content, and the maintenance of plant food by applying it in one form or another to the soil.

238. Why the Western Type is not Permanently Productive.—In the Western or New World type of agri

culture, which by the way is not confined to America alone and which is not the only type in America, the soil is too often considered a mine which the crop grower immediately proceeds to exploit. Immense areas of fertile soil at our door encourages us to skim the "cream" from this land and then pass on to do the same to other virgin soils. The individual finds a store of wealth in the soil and he does not hesitate to mine it. The State looks on more or less carelessly, realizing that it is being robbed, but offering no effective resistance because it knows none. And in many areas it has not yet set itself efficiently to the task of finding a more permanent system that is as profitable.

239. The Individual Versus the State.—Every old agricultural region in America has been first discovered, then exploited, and then some of them have been brought back to a state of normal production only at enormous expense of money and mental and physical effort on the part of later generations.

The surface, 6 2-3 inches of an acre, of our average loam soil contains a potential wealth of $1,250 or enough to produce 5000 bushels of wheat. Shall we in the light of all the ages dissipate the best of this enormous wealth and having done so then proceed in the face of untold difficulties to build it up again? The indications are that we shall not take a lesson from the history of the past, but that we shall continue to do the thing that is profitable to the individual regardless of its effect on the state and on posterity.

240. Organic Matter and Nitrogen.—No agricultural country has ever prospered for more than a generation or two that has not made provision for maintaining the nitrogen and organic matter content of the soil. Nitro-

gen can be maintained by applying nitrogenous fertilizers or by growing legume crops. Organic matter can be maintained by adding it to the soil in the form of manure, or grass roots, or crop residues or green manure. Commercial nitrogenous fertilizers are out of the question for Western Canada for a long time to come and legume crops must therefore eventually be grown to provide the fast decreasing supply of nitrogen in our soils; and either legumes or grasses or both must be grown or annual crops must be plowed under if we are to maintain the organic matter of the soil. And if legume crops or grass crops are grown there must be live stock to dispose of them.

241. Why "Mixed Farming" is Delayed.—But none of our commonly grown legume forage crops nor grass crops yield well in much of the plains area, and the difficulty of solving the problem is thus increased. The other chief hindrances to the more general adoption of mixed farming are the memories of unstable market conditions for live stock in the past and the high overhead charges for farm improvements. The live stock commission we hope will find some correction for the marketing difficulties. But aside from this the introduction of live stock requires a large financial outlay for fencing, buildings, stock and other equipment. So long as these are high priced and labor as expensive as it is, and interest rates as high as they are, shall we blame the individual farmer who exploits the soil when it is the only thing that is cheap among all the factors of production?

Our foremost investigators and students of agriculture, while not regarding live stock as absolutely essential to soil productiveness nor to permanent agri-

culture, do regard it as the most sane and most expedient and, under our conditions, the best paying and most advisable method of (1) lessening the risk in farming and of (2) aiding in maintaining soil productiveness.

The establishment of a more permanent system of agriculture can be aided and advanced more effectively at this time in our history by making the financial disabilities under which our pioneer farmers are working less onerous than they are to-day. If society is really concerned about the future of the state it should see that so far as possible no unfavorable economic conditions surround its basic industry, or else it should not blame the agricultural section of the community for doing the thing that it believes to be the most profitable, even if in the process the potential wealth of the state is dissipated.

242. Present Tendencies.—There is every evidence that the increase of soil "drifting", the spread of weeds, and the injury to crops from drought and frost, are not only lowering the yield on our Western soils, but are at the same time seriously increasing the cost of crop production.

To offset or remedy the first two conditions and to lessen the risk of danger from the last two, it seems essential that in many parts of the west two things must be done, (1) replace our one crop system of farming by a more general one, and (2) introduce more live stock.

Diversification in cropping and the use of live stock on farms aid very materially in controlling weeds and drifting soils and in lessening the danger from drought and frost. They do these at a very small maintenance cost to the farmer. Of course an initial capital expendi-

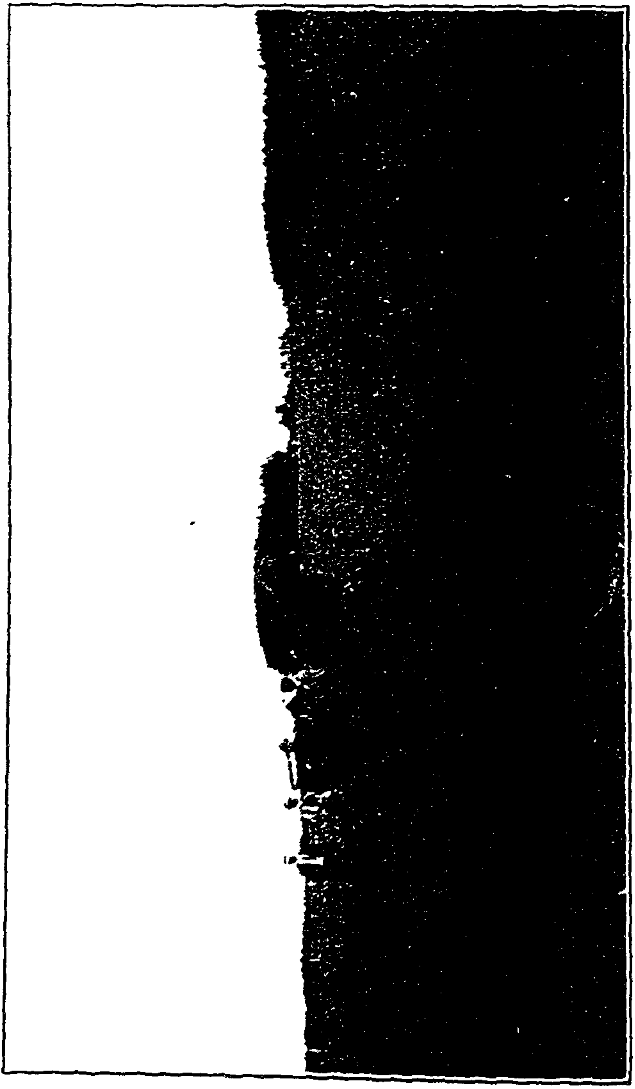

Fig. 89—Alfalfa on the Farm of John McKillop, Carnduff, Saskatchewan

ture for fences, buildings and stock is necessary. Tillage, on the other hand, while it helps to control these conditions, does so at a heavy and ever-increasing annual cost.

If we are to grow crops at a profit when "war" prices are a thing of the past we must lower the cost of producing them. If we are to continue growing profitable crops, we must take steps to maintain soil productiveness—in other words, at this time, to control weeds and to prevent soil drifting.

We can lower the cost of production and control weeds and soil drifting and at the same time build up a safe, sane and permanent agriculture by diversification of crops and the more general use of live stock on our farms.

The best crops to use, the order they should follow and the specific details of the management of a "mixed farm" vary under different conditions and must, therefore, be determined by the man on the land. At this time in our agricultural history no perfect plans that have stood the test of time are available. They have yet, very largely, to be developed and the farmer and the Experiment Station must work them out.

The purpose of this chapter is to present some evidence concerning the suitability of the different hay, pasture, soiling and fodder crops to Western conditions, in the hope that the information may be found useful to men who realize the shortcomings of our present system and are seeking to build up a better one.

243. The Stockman's Classification of Forage Crops.—In the broadest sense "forage crops" include all crops, any portion of which may be used as food for animals. As generally used, however, it does not include the "con-

centrates" or threshed grains. Forage crops may be subdivided into:

(1) Hay crops—the small strawed crops that are cured by drying.
(2) Pasture crops—those harvested by the animals themselves.
(3) Soiling crops or "green feed"—crops cut green and fed to animals in the fresh succulent condition.
(4) Root crops—those crops the roots of which are used for animal food.
(5) Ensilage crops—those preserved in a succulent condition by the exclusion of air, and
(6) Fodder crops—the roughage from threshed grains, grasses and legumes, and from dry cured corn stalks.

244. Forage Crops Classified from the Soil Fertility Standpoint.—Forage crops may be classified according to their effect on the soil as follows:

1. Annual grass crops—oats, barley, rye, millet, etc., which take out plant food and leave little root fibre.
2. Perennial grass crops—western rye, brome, timothy—which take out plant food and leave considerable root fibre.
3. Perennial or biennial legume crops—alfalfa, sweet clover—which take out plant food but leave much root fibre and nitrogen.
4. Annual intertilled crops—which take out plant food and leave little root fibre. Some, like corn, leave much moisture and available plant food, while others like turnips leave little of either of these consituents.

Winter rye has much the same effect as the annual grain crops, and sweet clover an effect similar to the perennial legumes. These are the only biennials likely to be used extensively in Western Canada in the near future.

245. Culture under Dry Conditions.—In growing grasses, clovers and alfalfa, there are several practices now quite firmly established that differ somewhat from those in vogue in more humid areas. We look upon

Fig. 90.—Sweet, White and Alsike Clovers.
On the left, crossing sweet clover; right, variety rows of white and alsike clovers.

sowing these small seeds with a nurse crop as precarious in most places having less than fifteen inches of precipitation. Yet a thinly seeded nurse crop has considerable value in that it helps to lessen soil drifting and to smother weeds which may develop before the small

seedlings of the slow starting forage crops get established. Where moisture is the limiting factor in crop yields, a heavy "nurse crop" instead of being a protection, actually robs the young plants of the moisture necessary for their growth and often leaves them in such a weak condition that a severe winter may cause their death. The use of a thin "nurse crop" to be cut early for hay, has in many parts proven a desirable practice when seeding down to grass, but alfalfa should always be sown alone.

Fall sowing is not followed, for the reason that the autumn months are as a rule, quite dry and poor germination usually results. In addition, the plants have not time to make sufficient growth to thoroughly establish themselves before winter sets in. As a consequence, there is less likelihood of their living over this part of the year. Seeding in June preferably in the early part, has been found most satisfactory, although some men sow the hardier grasses, such as timothy and rye grass at the same time as, and often with, the seed of the spring sown grain crops.

Drilling rather than broadcasting the seed, is the general rule. The surface soil is often too dry for good germination and not infrequently high winds are apt to blow away many of the lighter seeds if sown by the "broadcast" method. In a dry climate the moisture conditions necessary for germination are controlled much better by drilling. Some men still broadcast the seed and harrow it in, with very good results when the moisture conditions are favorable.

246. Perennial Crops for Hay and Pasture.—The hay and pasture crops that live longer than two years and that are best suited to western conditions are of two kinds—grasses and legumes. The three best grasses are

western rye grass, brome grass and timothy. Three grasses of lesser importance are Kentucky blue, red top, and meadow fescue. The best perennial legume is alfalfa.

Fig. 91.—Table showing average yields in pounds per acre of air dried hay from different grasses and alfalfa at Saskatoon, 1912 to 1915 inclusive:

Variety	1912	1913	1914	1915	Average
Alfalfa	5847	3037	2985	2384	3563
Western Rye Grass	6300	2595	2284	2025	3301
Brome Grass	7400	2032	1733	1733	3234
Kentucky Blue Grass	3150	2867	390	1658	2016
Timothy	2000	1669	1930	1225	1900
Red Top	3700	1766	936	1158	1890
Meadow Fescue	3660	1391	726	858	1659

247. Western Rye Grass.—This is the western name for "slender wheat grass" which is a hardy, perennial, drought resistant, native grass. Owing to its more or less bunchy growth it is known locally as one of the "bunch" grasses. It is a vigorous, upright grower, having relatively few leaves and a rather stiff straight stem. The seed is carried in the form of a spike or head.

Western rye is one of the best grasses for general use. It is essentially a hay grass, but is often used for pasture. For the latter purpose, the quality of the pasture is much improved by mixing with the rye grass a small quantity of alfalfa or Kentucky blue grass, or both.

If used for hay, rye grass should be cut as soon as the plants start to bloom, otherwise the forage will be found to be coarse and woody. In the drier parts it yields about the same amount of hay as brome grass. On the heavier soils of the more humid regions, it is approached in yield by timothy. Seed forms readily

on western rye grass and can be easily saved. The straw from the mature threshed hay, while generally utilized as roughage, is not of very high value for feed.

In sowing, 12 to 14 lbs. of seed is used per acre. On account of the loose, bulky character of the seed, it is

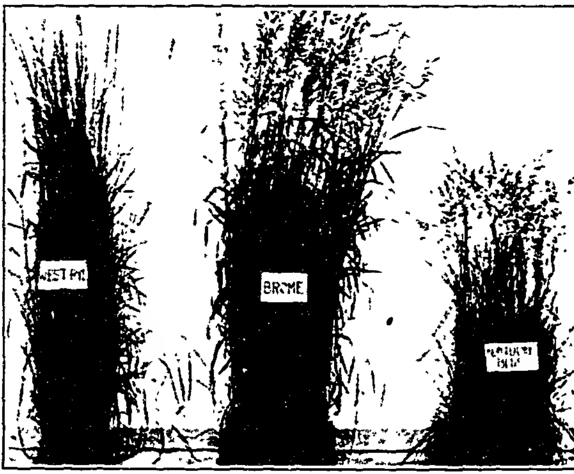

Fig 92.—Western Rye Grass, Brome Grass and Kentucky Blue Grass.

difficult to sow with the ordinary drill unless a small amount of some heavier seed, such as oats, is used to make it run out evenly. This difficulty causes many to sow it broadcast when they would otherwise drill it in. The crop produces from 300 to 500 pounds of seed per acre under favorable conditions.

Western rye grass seed shatters very easily. When grown for seed the crop should, therefore, be cut with the binder as soon as the heads commence to change to a brown color. At this time the seed is generally in the

dough stage. The sheaves should be stooked as wheat is stooked, and stacked preferably near the buildings, to be threshed when convenient. If the sheaves are well dried they may be threshed from the stook. A common method of threshing is outlined by Mr. T. W. Burns, a prominent rye grass grower of Stoughton, Sask., as follows:

"Leave one row of teeth in the concaves and lower the latter so that the straw will not be broken very much. This is important in order that there may not be any short, broken straw in the seed as it comes from the separator. Wind enough should be put on so that as much chaff as possible will be taken out. The seed may appear to be going out over the shoe. The operator of the separator must determine whether this is chaff or seed as the hull and chaff appear much the same as the seed. The shoe should be adjusted so as to take out all short straws so that as little chaff as possible will be returned to the cylinder. It is best to remove the weed and seed screen from the separator as no weed seeds can be taken out. If left in, this screen is likely to become clogged. The weed seed opening under the separator must be closed. The weighing hopper should be fastened open so that the seed will run continuously. It is not possible to weigh it. Western rye grass should be cut with the binder and tied in small tight sheaves. When the separator is properly adjusted this crop can be threshed fairly fast."

248. Brome Grass is a hardy, drought-resistant perennial grass that was introduced to the west from Central Europe in the early nineties. It has a creeping "underground stem" which sends up new shoots from its joints, thus forming a thick, even growth of grass and a dense

mass of roots. It is the so-called "creeping root" which makes this grass at once drought resistant and hard to control. It is a strong, upright grower, having many leaves and a long slender stem. The seeds are carried in the form of a loose, open panicle.

In the drier areas it vies with western rye grass for first place, usually yielding as much hay and more and better pasture. In many places it is considered a pest, owing to its persistence and the difficulty experienced in eradicating it. Its use is not recommended in the more moist areas, and only in the drier parts after its objectionable characteristic has been made known. The hay is more leafy and more difficult to cure than western rye grass. It is looked upon with less favor by horsemen, but feeding tests show it to be more nutritious than western rye and superior to the latter for cattle and sheep.

Brome grass is sometimes sown in a mixture with alfalfa, either for hay or pasture. This mixture usually produces good yields, but on account of the tendency of the brome grass to become "sod bound" after being down two or three years, most men prefer to sow each crop by itself. Brome is an excellent pasture grass, starting early and giving a good aftermath. Even when "sod bound" it produces a thick, though short growth of leaves. When brome is sown alone the first crop (the year after seeding) is usually the best. When sown with a nurse crop—the general practice—the first and second crops are fair, and each succeeding one is lighter, except when the rainfall of the later years happens to be greater than in the earlier ones. Generally brome grass is left down only two years.

Brome grass may be sown with or without a nurse crop. When the seed is sown alone, the same difficulties are experienced as in seeding western rye; the same amount of seed is also used. Brome grass may be cut for hay any time after heading and before the seed begins to shatter. The later it is cut the easier it is to cure, and the more suitable the hay for working horses. For cattle and general winter feeding brome grass should be cut when it is well headed out and beginning to turn purple.

Brome grass forms seed freely, often producing 300 to 500 pounds per acre. The straw from the threshed hay is of fair feeding value and is preferred by some to the green cured hay for horses at hard work. When grown for seed the crop should be cut as soon as the seed may be stripped off easily with the hand but before it shatters to any extent. In growing brome grass for seed care should be taken to see that it is sown on land that is free from quack grass, as this impurity cannot be removed from the seed by cleaning. The same applies to the growing of western rye grass seed.

The common procedure in threshing brome grass as outlined by Mr. J. Stueck of Abernethy, who grows a large acreage of it, is as follows.

"Take all the teeth out of the concave or if any are left in set it low. Put in the oat sieve, shut most of the wind off and run the separator somewhat slower than for wheat or oats. See that the sieve is not loaded too much. Gauge the wind carefully and watch the sieve. I find it is better to blow the very light stuff over than to thresh it too dirty as it is rather hard to clean."

A field of brome grass that has become sod bound can be renewed by plowing shallow in early summer and cultivating lightly through the season. The succeeding

crop is usually a heavy one. The sod may be broken up and the grass eradicated by plowing and "back-setting" or by plowing in a dry season after the grass

Fig. 93.—Timothy, Red Top and Meadow Fescue.

has been pastured off or cut for hay, and disking as necessary. Extra cultivation is nearly always required to make its eradication complete.

249. Timothy is a hardy perennial grass, but one that is unsuited for dry areas. It is a "bunch" grass, having a shallow root system, and does best in heavy soils in humid regions. It makes excellent hay for driving horses, but it is not a good pasture grass except for use in mixtures. The most favorable reports concerning this grass come from the humid parts of Manitoba, the lower foothills of Western Alberta, the more humid parts of Northern Alberta and from the Kerrobert, Moose Moun-

tain and other local areas in Saskatchewan. It is considered the best grass for use on irrigated land.

The ease with which seed can be secured, its relative cheapness, the reputation of the hay for feeding to driving horses and the adaptability of the crop to the more moist areas are reasons for its popularity. In milder climates it is often sown with red clover and alsike for hay, the fields to be used later for pasture. The clovers have not demonstrated their usefulness here yet but alfalfa might very well replace them in this mixture. A small amount of timothy seed is often added to the hay or pasture mixture even in the drier parts. When sown alone, five to eight pounds of seed are used per acre.

In western and northern Alberta the production of timothy seed is already a successful branch of farming. In discussing this subject for Alberta conditions Craig says: *"For seed production, timothy should not be sown too thickly; from five to six pounds per acre is quite sufficient. If seed were absolutely reliable and the conditions of soil and seeding wholly favorable to the germination of all the seed sown, seeding at a rate of as low as four pounds per acre might be sufficient. When land has been in timothy for two or three seasons, it will be found that the stand becomes so thick that the crop will be unproductive. Heavy discing and top manuring will improve such a condition but after two crops have been harvested it is generally wise to plow the land and sow to some other crop.

"Since the timothy seed is small, it is very difficult to separate the finer weed seeds with a screen. It will

* In Alberta Department of Agriculture Circular on "The Production of Timothy Seed in Alberta".

be found economical to hand-pull lamb's quarters or any other ripe weeds before cutting. It is very important that the crop should be cut at the proper stage of ripening else a good quality of seed cannot be expected. If

Fig. 94.—Seeds of Grasses Commonly Grown in the West.

the crop is cut as soon as the brown tinge is evident over the field the seed will be plump and will not hull to the same extent as if left to ripen further. On the other hand, too early cutting should be avoided on account of the injurious effect on the vitality of the seed. Observation leads us to conclude that too much of the timothy has been cut too late rather than too early with the consequence that a considerable quantity of the seed is lost by shelling and the appearance is unfavorably affected by the presence of a large percentage of hulled seeds.

250. Harvesting and Cleaning Timothy.—"Timothy can be handled best by cutting with the ordinary grain binder. The sheaves should be made rather small so that they will dry out quickly for threshing. It is wise to stook immediately after cutting and to handle as little as possible before threshing in order to prevent shelling. If the weather is favorable, threshing should commence within five or six days after cutting. If this is not

possible, timothy should be stacked carefully as soon as dry. When threshing, the concaves of the machine should be well opened and the machine run much slower than for grain. It will be found wise to keep separately the first seed threshed in case any weed seeds should have remained in the mill from a previous setting. If

Fig. 95.—Results of Tests with Western "Rye" Grass.
On the left, sheaves from "nurse crop" tests. The heavier and later the nurse crop grows the lower the yield of the hay the following season. On the right, representative sheaves from rotation tests.

the above matters are observed closely the seed will not be hulled, and should be of a good color, plump and free from weed seeds. Before marketing, timothy seed should be run through a fanning mill sufficiently often to clean out the chaff, weed seeds, etc., then stored carefully in a place which is thoroughly dry."

251. Kentucky Blue Grass.—Next to brome grass, this is one of the best to use in mixtures where pasture is desired. It has creeping underground stems and forms

a close, dense mat on the surface of the soil. Ordinarily it does not grow high enough to give a good yield of hay. It should seldom be sown alone, even for pasture. When sown with western rye or timothy, it increases the pasture value of these crops. It starts earlier than most of our other grasses, and continues to grow as long as the moisture in the soil permits. Being shallow rooted its growth is seriously checked by prolonged periods of drought. It is eagerly sought for by animals and is of high feeding value. When sown alone, twelve pounds or more of seed should be used per acre.

252. Red Top is essentially a low land pasture grass. It is suited to wet acid soils and to low lying valley lands. It is a hardy perennial having a creeping root. It, too, forms a close sod which stands tramping well. The growth is generally short and thick. The pasture is liked by all kinds of stock, but is not so palatable or so nutritious as Kentucky blue. Alsike and white Dutch clovers are sometimes used with it for pasture. Western rye and timothy are also often mixed with it to give bulk to the pasture for hay. Red top should seldom be sown alone but if this is done ten to twelve pounds ("fancy" seed) should be used per acre.

253. Meadow Fescue is used both for hay and pasture. In the drier parts it does not yield well. In moist seasons it compares favorably as a pasture grass with western rye but in dry ones it is not productive. It is very much inferior to brome for pasture. It is a hardy perennial, but not drought resistant. It produces a fair yield the first year, but succeeding crops are often disappointing. For this reason it is not popular and when used it is in mixtures with other standard sorts.

When sown alone, as much as fifteen to twenty pounds of seed is considered necessary to sow an acre.

254. Alfalfa.—A hardy, drought-resistant, leguminous hay crop has long been desired by the farmers in the older parts of the west. Such a crop is a necessity from the point of view of soil conservation and very desirable as a supplement to the forage crops now grown. Some varieties of alfalfa when properly managed, combine all the qualities mentioned above. This crop promises to be a very useful one in many areas, both as a soil improver and as a forage crop. (See Sec's. 255 and 270).

255. Suitability to Soil and Climate.—Alfalfa can be grown on practically all normal soils. Alkali and low

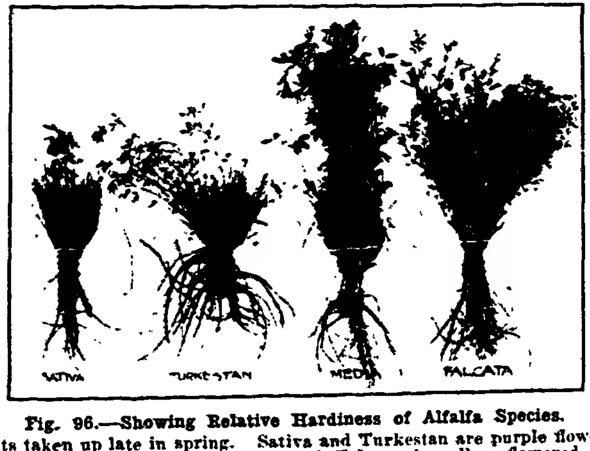

Fig. 96.—Showing Relative Hardiness of Alfalfa Species.
Plants taken up late in spring. Sativa and Turkestan are purple flowered alfalfas; Media is variegated, and Falcata is yellow flowered.

lying soils, which are subject to flooding are unfavorable to alfalfa, but on the normal loams and clays it finds a satisfactory environment. On heavy soils it produces a larger yield of forage than on the lighter types; but on

the other hand the production of seed is generally greatest on the warmer and earlier soils. Alfalfa is not suited to short rotations because of the high cost of seed and the difficulty of plowing the alfalfa sod.

It is doubtful whether at the present price of seed of hardy varieties, alfalfa can be grown profitably for hay in the drier portions of the west. In these parts, however, alfalfa seed can be grown very satisfactorily if the crop is sown in rows two and one-half or three feet apart. For forage alfalfa does much better in the humid than in the dry parts. It reaches its greatest perfection on the irrigated lands of southern Alberta.

256. Varieties.—During a period of seven years approximately one hundred strains of alfalfa were tested by the Field Husbandry Department of the University of Saskatchewan. As a result we are able to say with some confidence that Grimm is the most suitable for the Province of Saskatchewan. This agrees with the findings of all of the other experiment stations. There is now no doubt but that the true Grimm under good cultural conditions will withstand the low temperatures of all normal winters here.

257. Soil Preparation and Seeding.—Alfalfa should be seeded in the early part of the rainy season, or between the middle of May and the middle of June. It gives best results when sown on fallow or on ground that has been in hoed crop the previous year. Soil which has been well manured before a hoed crop furnishes probably the best conditions for starting alfalfa. Weeds are always a drawback to the crop but grass is its worst enemy. Alfalfa should not be sown on land that has not been freed from the creeping rooted species of native or introduced plants. Thin seeding has given best results as

thick stands suffer most in periods of drought and on the average yield less than thinner ones. On weedy land thicker seeding is necessary because of the fact that many plants are smothered out before they are large

Fig. 97.—Showing Relative Hardiness of Alfalfa Varieties.
Plants taken up in late spring.

enough to compete successfully with weeds. Thorough preparation of the soil before seeding to alfalfa is essential to the production of profitable crops. On soils that drift the seeding should not be done when the surface is loose and dry but preferably after the first rains when the surface soil is firm and less inclined to drift.

Broadcasting the seed without a nurse crop is quite often followed, and, if sown in the rainy season on well prepared soil that is not inclined to blow, it generally gives good results. The most successful farmers are now, however, drilling in the seed. Some use the grass

seed attachment of the ordinary grain drill, while others increase the bulk of the seed with cracked wheat or barley or other material which has been sifted to a uniform size a little larger than alfalfa seed and sow through the grain box. By drilling the seed the conditions necessary for germination are more easily controlled and less seed is necessary. From eight to twelve pounds of good seed is quite sufficient for an acre. A nurse crop should not be used.

258. Alfalfa, a Soil Improver.—Alfalfa is a "legume". It has the power when "inoculated" of drawing upon the atmosphere for a part of the nourishment that other classes of crops must take from the soil. Inoculation simply means adding alfalfa bacteria to the seed or the soil where the seed is to be or has been sown. These bacteria then live in "nodules" that develop on the roots of the alfalfa, and they pay for this privilege by extracting from the soil air such an amount of nitrogen as the soil may not be in a condition to furnish the crop. Only "legume" plants can draw upon this supply of nitrogen and these only if bacteria are present in association with their roots.

"Inoculation" can be effected by taking soil between the depths of two inches and six inches from an old productive alfalfa field and applying it to the field to be sown, or the soil may be mixed with the seed before sowing. The soil so used should not be allowed to dry out before it is applied which should be on a cloudy day. After applying the soil the field should be harrowed immediately in order to get the inoculated soil well mixed into the land so that the bacteria it contains may not be killed by the sun's rays. Ordinarily between 200 and 500 pounds of soil per acre is used.

Another method that may be followed is to purchase an artificial culture of alfalfa bacteria and apply it to the seed before sowing. This often gives better results than the soil method of inoculation, but sometimes the

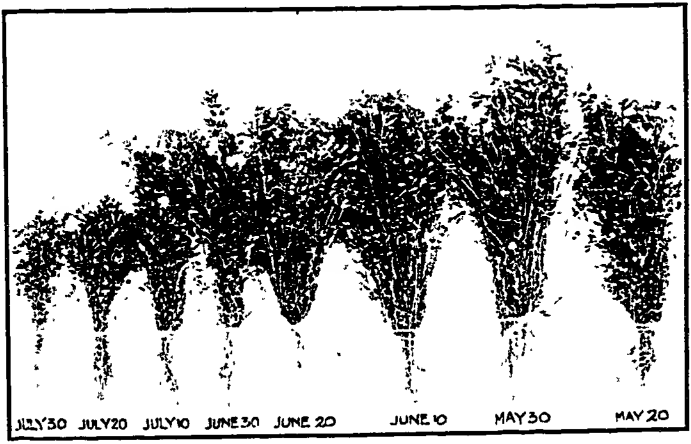

Fig. 98.—Relative Growth of Grimm Alfalfa at Saskatoon.
Results secured from seeding at different times the preceding year.

bacteria in the cultures are killed by unfavorable conditions during transportation. The soil method is the surest but the pure culture method is sometimes the most effective. Increased yields of from three hundred to one thousand pounds per acre as a result of inoculation have been reported.

A third, known as the glue method of inoculation, seems to be coming into more general use. It consists of adding six or eight ounces of furniture glue to a gallon of luke warm water. After the glue has been thoroughly dissolved the solution is sprinkled over a bushel of seed. The seed is then thoroughly mixed so

that every kernel is brought into contact with some of the glue water. To this seed a quart of dry, pulverized soil that has been taken from around the roots of a healthy, well-developed alfalfa plant is added. The seed and soil are then thoroughly mixed until every seed is brought into contact with some of the soil particles. As the mixture dries it should be stirred frequently to prevent the seed sticking together. The treated seed should be kept in a cool, dark place and out of the sunlight. Seeding within twenty-four hours after treatment is advisable.

259. Clip Back to Control Weeds.—When seeded on land that has produced a crop of cereals the previous year many annual weeds come among the alfalfa plants. These can be controlled only by clipping back the crop with a mower. Clipping is not desirable except where it is necessary to control weeds. No crop is expected the year the seed is sown, but on the heavier soils in the more humid parts and particularly in moist seasons a crop may sometimes be taken. It has been demonstrated conclusively time and time again that a growth of six to ten inches should be left on the field in the fall in order to protect the plant roots by holding snow in the winter. Invariably this practice results in increased yields the following year and in longer life to the field.

260. Harvesting.—In harvesting alfalfa, three things should be remembered, first, that its feeding value is greatest if cut just after blooming has commenced; second, that the leaves, which fall off with the slightest provocation when dry contain by far the most valuable part of the crop, being equal in feeding value to wheat bran; and third, that rain not only discolors the hay and makes it less palatable and less digestible, but also

removes in solution some of the nutritious constituents of the fodder.

The crop should not be cut while wet nor while the dew lies upon it. When 10 per cent. or thereabouts of the plants are in bloom cutting should commence. It

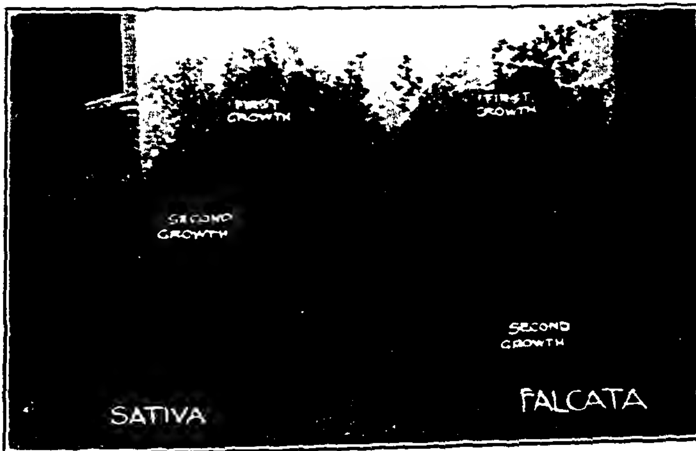

Fig. 99.—First and Second Growth of Alfalfa.
Common alfalfa, (Sativa) and yellow flowering alfalfa, (Falcata) showing vigorous second growth of the former and characteristic poor second growth of the latter. Grimm resembles Sativa in this respect.

has been observed that if cut later than this the yield is less than it would otherwise be, due to the clipping back of the new shoots which ordinarily appear at this time. The appearance of these young shoots at the base of the plant is one of the best signs that cutting should commence. Recent experiments seem to indicate that later and fewer cuttings result in longer life to the plants.

Since quick drying in the sun makes the leaves brittle and causes them to break off easily, it has been found advisable to rake shortly after cutting and cure

in the cock. If left in the windrow, the outer layers become dry and brittle, causing great loss of leaves and deterioration in quality. This is better than leaving it in the swath but not so good as curing it in the cock. The latter takes more time and labor than when cured in the swath or windrow, but always gives a much superior quality of hay. It is often advisable to turn the cocks over a few hours before stacking or drawing to the barn in order to dry out the lower layer next the ground. The practice of curing in cocks may have some disadvantages in exposed locations in windy weather, but when the alfalfa is raked before it becomes dry it will be found to settle down well, and, except in the heaviest winds gives very little trouble.

261. Surface Cultivation of the Crop.—In semi-arid regions the yield of a perennial forage crop is measured by the amount of precipitation conserved in the soil. The practice of disking, "renovating" or harrowing alfalfa in early spring when for three or four weeks after the snow goes the field is left practically bare and lifeless is to be recommended for fields that bake and for old fields in which grass is obtaining a foothold. The practice is not advisable on fields that are clean and the surface of the soil in good tilth, since it puts the crop back considerably, particularly if done after the new shoots have formed. The harrows do the least damage but are also the least effective where grass or a hard surface is found. The other implements should be used only when renovation is necessary. If used with care they will do but little harm to the plants and much good to the soil.

262. Growing Alfalfa Seed.—Alfalfa seed usually retails here at from 20 cents to over 75 cents per pound.

The price of the hardiest varieties which alone should enter into general use in the west has seldom been below 40 cents per pound.

It is apparent that when sown at the usual rate, and in the ordinary manner, the cost of seed is in itself sufficient to prevent many men from growing the crop. Eight to ten pounds per acre at 60 cents per pound is too much money to put into even alfalfa except perhaps on irrigated land, or in small patches near one's buildings. When the price of seed is reduced to 20 cents per pound one great objection to the growing of the crop will be removed; and even at this figure alfalfa seed production should prove a profitable undertaking.

Under these circumstances it would appear that the next step in the propaganda for more alfalfa should be the encouragement of seed production. If cheaper seed of our hardiest varieties were available there is no doubt that more alfalfa would be sown. Until seed is available at a reasonable price the cost of putting down land to alfalfa will continue to be a serious obstacle in the way of its production.

263. Possibilities of Seed Production.—In the year 1912 a yield of 300 pounds per acre of Grimm alfalfa seed was reported from a farm in southern Alberta; in 1913 on the same farm the yield was 150 pounds, and in 1914 about 40 pounds per acre. At Neepawa, in Manitoba, in 1914, an eight acre field produced at the rate of 300 pounds per acre of Grimm alfalfa.

On the University Farm at Saskatoon no alfalfa was grown in rows for seed until the dry year of 1914. In 36 inch rows sown at three pounds per acre the yield was 116 pounds in 1914, 100 pounds in 1915, and 110 in

1917. In 1916 owing to the heavy summer rains very little seed formed and the crop was cut for hay.

The nature of the alfalfa plant is such that, if at the time it is coming into bloom, or if already in bloom,

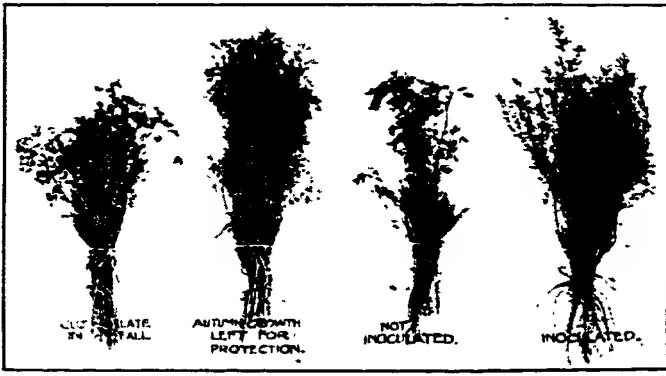

Fig. 100.—Representative Alfalfa Plants Taken Up in Late Spring. Showing (on left) relative hardiness and earliness where crop was cut late the previous fall as compared with same where growth was left for protection; and (on right) relative hardiness of uninoculated and inoculated plots.

rains occur, new shoots very soon appear at the base of the plant and seed formation stops. For this reason very little alfalfa seed can be grown in humid countries, and for the same reason it would seem that the drier parts of the prairies should be the best for seed production.

264. Suitable Varieties for Seed.—No figures on the relative value of different varieties for seed purposes are available. It has, however, been observed on the plots at the University of Saskatchewan that Grimm and other variegated sorts seem to set seed much more freely than any of the common varieties. Similar observations have been made at different places in the northern prairie

States. All information that has been gathered seems to point to the one conclusion, that Grimm is much more to be preferred for seed than any other variety.

265. Seeding in Rows.—In a three-years' test at Saskatoon 12 inch rows sown at 9 pounds per acre yielded 76 pounds of seed, 24 inch rows sown at $4\frac{1}{2}$ pounds per

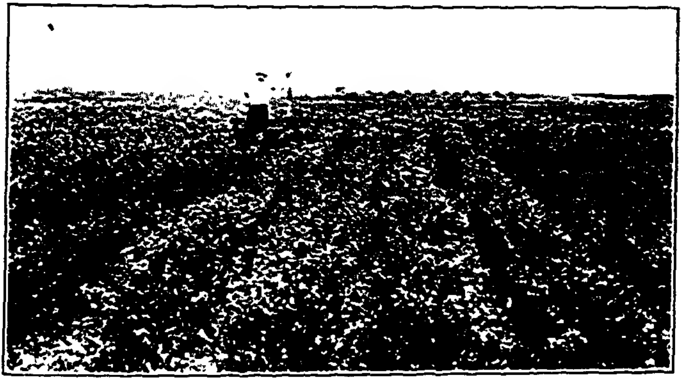

Fig. 101.—Grimm Alfalfa in 30 Inch Rows for Seed.

acre 80 pounds, while 36 inch rows sown at 3 pounds per acre yielded 108 pounds. These figures illustrate what has commonly been observed and often reported, viz., that for seed production alfalfa sown thinly in wide rows is likely to prove very much more satisfactory than when sown in any other way. Seeding in rows 36 inches apart, at the rate of from two to four pounds per acre, is likely to prove the most satisfactory method of production on our lighter, drier lands.

Even for hay this method of seeding has some advantages. The intertillage necessary adds to its cost but less seed is needed and the yield under dry conditions is

greater. In a three years test at Saskatoon 36 inch rows averaged 3240 pounds per acre; 24-inch rows 3160 pounds per acre, and 12 inch rows 2950 pounds per acre. The use of wide rows for hay is not a good practice in the humid parts but is worthy of trial in dry areas.

266. Preparation of Land.—When alfalfa is to be sown in rows for seed it is not necessary that the land be fallowed or even that inter-tilled crops precede it, although either of these preparations will, of course, give the crop a better start. Stubble land that has been worked in such a way as to rid it entirely of creeping rooted grasses is quite satisfactory. The land should be plowed deeply either in the fall or spring and a firm, mellow seed bed prepared.

The seed should be sown very shallow, never more than an inch in depth. The soil should be firm so that the moisture to germinate the seed will be available at the depth to which the seed is planted. When only a small quantity is to be sown the garden drill may be used. The best time for seeding is in the early part of the rainy season, usually during the first three weeks of June.

267. Inoculation Important.—For the same reason that inoculation is advisable when sowing alfalfa for forage purposes, it is also important that it be used when growing the crop for seed. The Bacteriological Department of the Ontario Agricultural College at Guelph or the Manitoba Agricultural College at Winnipeg have in the past supplied alfalfa culture at 25 cents per package. The Earp-Thomas Farmogerm Company of Bloomfield, New Jersey, has in the past supplied a very good culture at a higher price. The last mentioned, although ex-

pensive, has given very excellent results at Saskatoon. When soil can be obtained free from weeds and plant diseases it is perfectly satisfactory to use. The packages referred to above usually contain sufficient culture to treat from one-half to one bushel of seed. Full instructions for using always accompany each package. (Sec. 258).

268. Cultivation.—When alfalfa is sown in rows for seed, weeds are likely to make considerable growth the first year, unless the land is particularly clean. To control the weeds it is necessary to intertill the crop; it is seldom necessary to hoe the rows, but even this is sometimes advisable. If the land is properly prepared and gotten as clean as possible the alfalfa, if sown at the right time, will make a very early start. Thereafter, intertillage should be given often enough to control the weeds and keep a mulch on the land and prevent the soil from baking and cracking.

If weeds grow up in the rows the year of seeding it is advisable to clip back the alfalfa. If all conditions are favorable and the crop makes a good growth the first season, a crop of forage may be taken. It should be kept in mind, however, that a considerable fall growth should be left on the field in the fall in order to gather snow and thus protect the plants against the low temperatures of the first winter. If it is thought that after the removal of the crop there is not likely to be much growth it is better to leave it uncut.

Occasionally it will be necessary to double disc or "renovate" old fields. This operation should be done as soon as the soil is in condition to work in the spring and before the plants make much growth, otherwise they receive a setback. Intertillage as needed to conserve

moisture and to control weed growth should be given throughout the summer.

269. Harvesting Seed.—The harvesting may be done with the ordinary binder. As soon as most of the seed pods have turned brown or black, the crop may be cut.

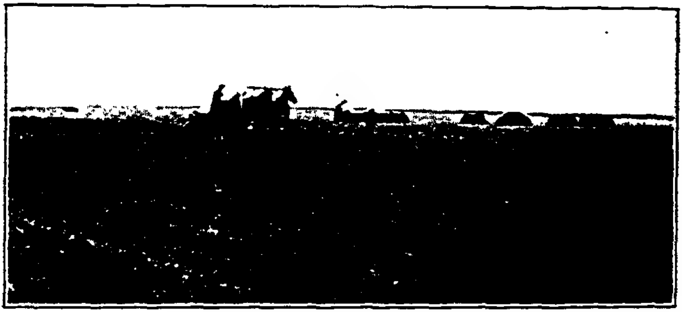

Fig. 102.—Harvesting an Alfalfa Seed Crop.

This will generally be in the latter part of August, but in the more humid parts some of the seed is often more or less immature until the first fall frosts come. Seeds that are mature suffer no injury from frost, so that by delaying the harvesting of an undeveloped crop no damage is likely to result to the mature seeds and more of the immature seeds may ripen.

If the crop is well matured and dry, it may be tied in tight bundles, otherwise it should be tied in loose ones. The sheaves may be stooked after the same fashion as wheat. Long narrow stooks running north and south are preferable to round ones. It is generally desirable to stack it after the sheaves have dried out thoroughly. Stacking, hoewver, is not essential if the seed is mature and the sheaves dry out well in the stook.

270. Threshing Alfalfa.—Alfalfa can be threshed best by the use of a clover-alfalfa huller but fairly satisfactory work can be done with the ordinary grain separator by putting in all the concaves and closing them up as close as possible. The wind should be adjusted so that unthreshed pods will not be carried past the tailings augur. Most of the pods will leave the machine by way of the grain spout, and the threshed seed through the opening that usually carries off the weed seeds. All the unthreshed pods must be returned to the cylinder a second time which, if the alfalfa is dry, will usually effect a complete separation. The threshed seed will contain quite a proportion of chaff and broken stems which can easily be removed by the fanning mill.

271. Native Grasses.—The native grasses are largely used for hay and pasture in all new districts. "Prairie wool" and "slough hay" constitute the greater part of the forage used in the early history of prairie farms. When cut in good time, this native vegetation makes very nutritious hay. The upland grasses are not seriously injured by over maturity but after slough hay has become frozen, the quality is very poor. The native hay usually includes, in addition to numerous grasses, a number of native legumes which increase the protein content of the whole, thus improving it in quality. As long as the supply of native hay is abundant there is usually little need for sowing cultivated perennials. When cut at the right time and properly cured this hay does not differ essentially in feeding value from that produced from the cultivated grasses. (Fig. 109).

272. Mixtures for Hay and Pasture.—Under some conditions mixtures of grasses, or of grasses and legumes, produce larger returns than any one of the constituent

crops grown singly. Our experience at Saskatoon has not borne out this contention when the crop has been cut for hay. Where pasture is desired or where both hay and pasture is expected mixtures generally give rather better satisfaction than single crops.

The following are among the mixtures that are likely to be found satisfactory in different portions of the west:

1. Western rye 8 lbs., brome 6 lbs.
2. Western rye 10 lbs., Kentucky blue 6 lbs.
3. Western rye 8 lbs., timothy 3 lbs.
4. Western rye 10 lbs., alfalfa 3 lbs.
5. Brome 8 lbs., alfalfa 5 lbs.
6. Timothy 4 lbs., alfalfa 5 lbs.
7. Western rye 8 lbs., Kentucky blue 4 lbs., alfalfa 3 lbs.
8. Western rye 5 lbs., brome 3 lbs., timothy 2 lbs., alfalfa 3 lbs.
9. Western rye or brome 8 lbs., red top 4 lbs., alsike clover 3 lbs.

Those containing alfalfa will be found most productive, but when used for hay two cuttings may be necessary in order to secure the greatest yield. The mixtures containing brome grass or brome and alfalfa are likely to give the best pasturage.

The mixtures in which western rye predominates will be found best for hay in a large part of the plains region, and in the same region those containing western rye and either alfalfa or Kentucky blue grass will be found suitable for pasture. On some suitable soils in this area timothy may replace a part or all of the western rye. Where brome can be eradicated without difficulty it should replace rye in pasture mixtures.

Mixture No. 9 is recommended for low lying soils that are subject to flooding. It should also be found useful for slightly alkaline areas. Where the alsike is found to kill out, the amount of the other crops should be increased and the alsike omitted.

Under favorable conditions ½ lb. each of red clover, alsilke, alfalfa and perhaps white clover might replace

Fig. 103.—White, Alsike and Red Clovers.
Showing typical growth characteristics. From left to right, White Dutch, Alsike and two varieties of Red Clover.

an equal weight of the other seeds. While the clovers mentioned are not considered commercially successful in more than a few areas, it is possible that some of them may find a suitable environment in some places where they have not been tried. They are likely to do best on heavy soils in the more humid parts and under irrigation.

273. The True Clovers.—Red, alsike and white Dutch are very little grown for forage in Western Canada. They are not well suited to our climate. None of them are drought resistant, and most strains of red and alsike

are not hardy enough to live through our winters. Their best use at the present time is to form a small proportion of mixtures for hay and pasture in the more moist parts of Manitoba, the park belt of the other provinces and on irrigated land.

274. Alsike has proven rather hardier than red clover. It is rather better, also, for low lying soils. Some strains of red clover recently introduced from Siberia promise greater hardiness than any heretofore tried. White Dutch clover is a perennial. It is hardier than red or alsike and is much used for lawn grass purposes in a mixture with Kentucky blue grass. It is so short that it is unsuitable for hay purposes. It is, however, sometimes used with standard grasses to form permanent pastures. These crops should seldom be sown alone in the west except for experimental purposes. Under these conditions 10 to 12 pounds of red clover, 7 to 10 of alsike and 6 to 8 of white clover per acre is sufficient to sow.

275. Sweet Clover.—The so-called sweet clover is a tall-growing biennial plant, having coarse branching stems which bear white or yellow blossoms, and carry relatively few leaves. It is a "legume" but not a real clover. Nevertheless it has the power in common with clover, alfalfa, and other legumes, when inoculated with suitable bacteria, to gather nitrogen from the air.

276. Undesirable Qualities.—Sweet clover has several undesirable qualities. It is bitter, coarse, hard to cure, may become an impurity in alfalfa seed, and in waste places is likely to persist.

Cattle, hogs and sheep pasture it quite satisfactorily when it is young, but they do not like it when mature, nor can it be made into hay that is palatable after the

blossoming stage. Most animals dislike the plant even in the young condition, but they generally develop a taste for it if kept from other feed for a short time.

For best results the crop must be either pastured while young, or cut for hay before the blossoms develop.

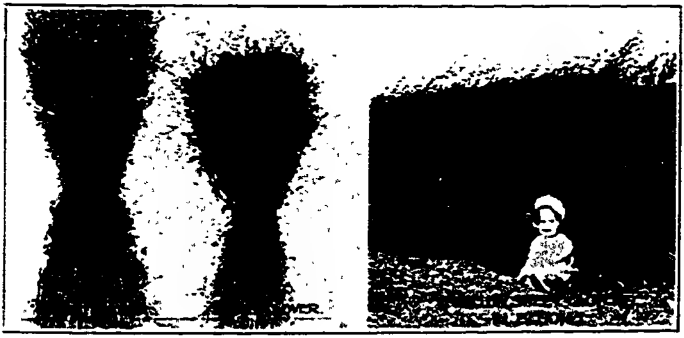

Fig. 104.—Sweet Clover Cut and In Bloom.

On the left, sheaves of white and yellow sweet clover, and on the right, white sweet clover in bloom.

Its value for hay even when cut early, has not yet been fully demonstrated in this country, but in portions of the central western States it is regularly used for this purpose.

The same difficulties experienced in curing alfalfa are to be met with in handling sweet clover. It carries a large percentage of water which makes it difficult to cure, and in addition the leaves fall off readily after drying.

The seed resembles alfalfa so closely that if once mixed the two kinds cannot be satisfactorily separated. For this reason the use of sweet clover in possible alfalfa seed growing centres should not be encouraged until its value has been more positively determined.

In waste places where the land is not plowed every year sweet clover is sure to persist. The fact that it is a biennial, which seldom seeds the year it is sown, is sufficient guarantee that it will not become a weed on land that is plowed every year. Under these conditions it cannot reproduce itself. If, however, volunteer plants of one season are not killed by plowing or other means in the autumn following they are quite sure to be present the next year.

In this connection it should be pointed out that the yellow flowered sweet clover, while less hardy, is much

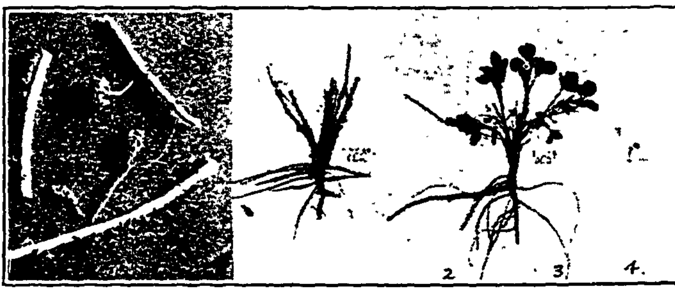

Fig. 105.—Sweet Clover.
Showing (4) seedlings, (3) early spring growth after first winter; (2) dead plant after second winter; (1) nodules on the roots.

more likely to reproduce itself from seed and therefore to become more troublesome than the white flowered species. The latter has in the past been recommended more highly owing to its taller, more vigorous growth. The yellow species is, however, earlier, less coarse, more leafy and a heavier seed producer. Only time will tell which will be superior here, although present indications favor the white flowered species.

277. Good Qualities.—Among the chief redeeming qualities of sweet clover are, first, its suitability to the

climate; second, its high productiveness; third, its biennial character; and fourth, it is a "legume".

Sweet clover grows nearly a month before corn is up and generaly remains green for a month after corn freezes in the fall. It is seldom seriously injured by spring or fall frosts. For this reason the crop is peculiarly suited to the short growing season and the severe temperature conditions of Western Canada. Chemical analysis shows it to be rich in protein, being almost as high as alfalfa in this constituent. But unless cut in the early stages of growth it is neither as palatable nor as digestible as alfalfa.

The biennial character of sweet clover is much in its favor. The chief fault of all perennial crops, including alfalfa, western rye grass, brome grass and timothy, in a dry climate, is that they give no favorable opportunity for storing a surplus of moisture after the year they are sown. As a result perennials do not yield a large annual return under dry conditions after the first crop. Although a biennial, sweet clover may be used as a perennial pasture crop by allowing some of the plants to develop and shatter seed each year.

It has been observed also that sweet clover is much more easily plowed than alfalfa land, for the reason that after the second season, the sweet clover roots are dead and partially decayed and do not therefore increase the draft in plowing. It is common knowledge that alflafa fields are plowed only with great difficulty.

Sweet clover is a nitrogen gatherer. In this respect it is similar to the commonly grown clovers and alfalfa. It is an interesting fact that the bacteria that produce the nodules on sweet clover is the same species as that used to inoculate alfalfa.

When sown in rows two and a half or three feet apart and cultivated the crop yields more in the dry areas than when sown in close rows with more seed, but a much finer quality of hay is secured from the thick seeding than from the use of wide rows. It would seem that unless the crop is used altogether for pasture or possibly for silage that the coarseness due to seeding in wide rows will be such a disadvantage that this practice will not be found satisfactory.

The claim has been made that sweet clover is resistant to alkaki in soils, and considerable evidence has been advanced supporting this contention. It has been observed, however, that it did not prove satisfactory on certain alkaline soils in the west. It is probable that the crop is somewhat resistant to alkali but that it will not grow under badly alkaline conditions.

It is well known that sweet clover is looked upon with favor by apiarists as a valuable honey plant.

278. The Culture of Sweet Clover.—The cultural practices for sweet clover have not been well worked out for this climate. It is hoped that sufficiently hardy strains may be found or developed to withstand our winters when sown with a nurse crop. If this can be accomplished there is little doubt about the future usefulness of sweet clover in much of the prairie area.

Like most other crops sweet clover will do best if sown on fallowed land. On account of its biennial nature, however, this preparation is too costly unless it can be used with a nurse crop. Quite satisfactory stands can be secured from sowing on well worked fall or spring plowing that is free from grass. The surface soil should be quite firm and the seed when used alone should be sown in the rainy time—generally in the month of June.

Since sweet clover seed contains a large percentage of "hard" seeds which fail to germinate unless frozen or "scarified" or treated with some chemical to weaken the impervious seed coat, only "scarified" seed should be purchased. If sown in rows 24 to 30 inches apart for seed, 3 to 5 lbs. per acre of such seed is sufficient. When sown broadcast or in six inch drills, 8 to 12 lbs. or more should be used.

In most seasons the crop will grow to a height of one or two feet the first year. This may be lightly pastured or cut for hay, but it is better left standing to hold snow. The following year the first crop is generally ready to cut the latter part of June, and the second crop the latter part of July or August. The first crop

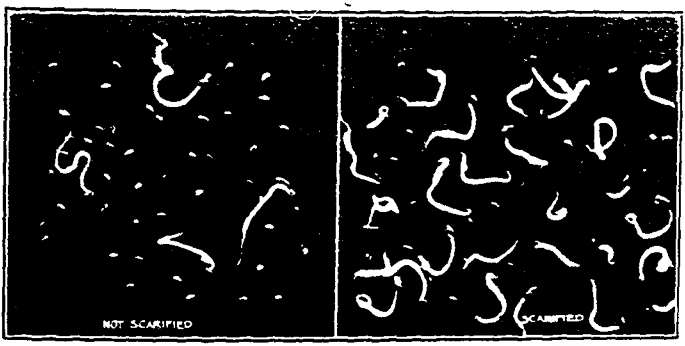

Fig. 106.—Germination of Sweet Clover Seed.
Showing characteristic low germination of "unscarified" seed, and good germination from "scarified" seed.

should be cut early and high. If left uncut very long after the first sign of blooming or if cut too close to the ground the after growth or second cutting is likely to be a partial or complete failure.

Sweet clover needs to be well cured in the swath, windrow or cock before being stored in either stack or barn. If the crop is used for pasture only, the tall growing stems that get ahead of the stock should be clipped back occasionally with a mower to prevent seeding and to encourage the development of fresh green shoots.

In case it is desired to grow the crop for seed it should not be cut for hay early in the season. For seed purposes rows about two feet apart are often used. When grown in wider rows the seed is later in ripening and therefore more subject to injury from fall frosts. The yellow sort may be sown in wider rows than the white since it is both shorter and earlier than the latter. Harvesting may be done with the grain binder, the sheaves being tied as with grain. The threshing can be done satisfactorily with the grain separator.

279. Probable Value of Sweet Clover.—At present the probable usefulness of sweet clover in Western agriculture seems to lie in its value as a pasture crop, a possible hay crop if cut early and as a soil improver. Heretofore a most serious weakness in our system of farming has been the lack of a suitable legume. If sweet clover proves hardy enough to withstand our winters when sown with a nurse crop it will be at once a valuable pasture and hay crop and will go far towards building up a more permanent system of agriculture in all those areas where red clover is not hardy and where alfalfa is not well adapted.

It should not be forgotten, however, (1) that sweet clover is bitter, particularly in the later stages of its development, (2) that in the mature condition it is coarse in texture and relatively indigestible, (3) that it is hard to cure on account of its large moisture content,

and (4) that it may become an undesirable plant in alfalfa seed growing centres.

Sweet clover has many good qualities and some very bad ones. If the latter can be overcome the crop will have a very important place in our agriculture. If they cannot it will occupy only a very limited sphere of usefulness. Investigations now under way should give such added information as is necessary to determine the relative place of sweet clover among our forage crops.

280. Annual Crops for Hay and Pasture.—The best annuals for hay, pasture or "green feed" are oats, peas and oats mixed, barley, winter rye, the millets, corn and rape.

281. Oats in the prairie sections is used for hay to a greater extent than any of the other cereals. On many wheat farms where native hay is not available, oat hay or oat sheaves and straw furnish the only roughage the working horses receive. For oat hay for horses the crop should be cut in the early dough stage. If it is to be used for cattle, cutting in the milk stage is preferable. This hay is found to be quite satisfactory, although when exclusively fed and particularly if it is quite mature, digestion troubles are sometimes experienced with horses. For cattle and sheep, oat hay is an excellent forage. An average yield of 2 to 3 tons of cured hay may be expected from fallow land of normal productiveness. Lower yields than this, of course, will be gotten from second and third crops after fallow. The standard grain varieties are the most productive of forage.

282. Peas and Oats.—The earlier varieties of peas, mixed with the late or standard varieties of oats, produce a richer and often a heavier crop than oats alone. This mixture is one of the most valuable for soiling purposes,

and it has been ensiled with considerable success at Lacombe, Alberta. (218). It is also used for both hay and pasture. Aurthur, Golden Vine or Early White peas and Banner, Victory or Gold Rain oats mix well together. The amount of peas used varies from ½ to 1 bushel mixed with 2 bushels of oats. The larger proportion of peas is preferred if the price is not too high. This mixture is more popular with dairymen than with any other class of stock men. It gives its best results in the park belt and eastern prairie section.

283. Barley as a hay crop is not so popular as oats, but in areas where weeds, such as wild oats, are troublesome, this crop is often used. It ripens earlier than oats and is, therefore, of more value as a cleaning crop. The early varieties can often be cut before Wild Oats mature enough to drop off. It yields rather less than oats. For forage the early maturing, beardless varieties, such as Success, which is hulled but beardless, are best.

284. Winter Rye is but little used as a forage crop, although it furnishes earlier pasture and soilage than any other crop. It is used to a small extent for hay. Its greatest value as a forage is in its earliness. It yields about as much as oats. Many other crops yield a better quality of hay but none are ready for use as early in the spring. When used for hay, rye must be cut early or the stems become stiff and unpalatable. Western strains of this crop are quite hardy if given a reasonable chance. N. D. No. 959 is one of the hardiest varieties. When sown early enough rye can be pastured lightly in the fall as well as in the spring. Too heavy pasturing in fall often results in partial or complete winter killing. When green, rye is reported to taint the milk of dairy cattle unless fed only immediately after milking time.

It should be sown as soon as possible after the third week in August at the rate of 1 bushel or more per acre. Spring rye is not as productive or as good a hay crop as oats, except on light soils. On these it may be found useful for hay. (See Chap. VII.).

Fig. 107—Two Commonly Grown Types of Millet.

285. The Millets are annual grasses that in Western Canada are used only for forage purposes. They are quick growers, large yielders, drought resistant, and very sensitive to frost. Millets grow slowly in the cool soil of early spring and are easily killed by fall frosts. They are not popular, for the reason that they are annuals and "warm climate" crops. They are used as "catch crops" or crops to substitute for other forage that promises partial failure. The annual yield is less than that of oats.

There are three types commonly grown—the foxtail millets, the barnyard millets and the broom corn or proso millets. The first is earlier and therefore better suited to western conditions. The leading varieties of

foxtail millets are Kursk, Hungarian and Siberian, the first mentioned being preferred. The seed is usually sown with a grain drill at from 20 to 25 lbs. per acre late in May, or early in June. The crop may either be pastured off or cured as hay. Being very leafy, curing is sometimes difficult. The hay is quite suitable for all classes of stock, but is fed mostly to cattle. If left too long before cutting, the forage is said to have an undesirable action on the kidneys of horses. When well cured it is rich in feeding value and nutritious.

236. Corn (*Zea Mays*) is as yet very little grown for forage and even less for grain in Western Canada, although for the former purpose it is an important crop in Southern Manitoba, and is worthy of careful trial in the drier and warmer parts further west. Under good management it yields 8 to 20 tons or more per acre, green weight. It is an excellent soiling and silage crop, and even its dry-cured fodder makes good stock food. (See Chapter XIII).

237. Rape (*Brassica Napus*) is a biennial crop that for forage purposes is used as an annual. It is a vigorous grower and gives a large yield of green forage which is used altogether for soiling or pasture. Yields as low as ten and as high as thirty tons, green weight, have been secured from fallowed land. The leaves contain so much moisture that they cannot be satisfactorily cured. Like turnips, rape will taint the milk of dairy cattle unless used in small quantity and immediately after milking

Rape is used principally as late summer and early fall pasture for cattle, sheep and hogs. It has special value for this purpose as it is able to stand quite heavy frosts without injury, often giving good pasture until late in October. There is some danger, however, to

sheep and cattle from bloat unless they are gradually accustomed to the rape pasture. This danger is greatest when there is dew on the plants and after they are frozen in the fall.

Rape is usually sown in rows two or three feet apart on well prepared land at three or four pounds per acre.

Fig. 108.—Sheep Pasturing on Dwarf Essex Rape.

While this is the usual practice the crop is occasionally seeded thinly with grain for the purpose of obtaining fall pasturage after the grain is removed. When sown in rows it is necessary to intertill the crop.

288. Mixtures of Annual Crops for Hay and Pasture.—The most commonly used mixture is peas and oats, but barley and oats, and barley, oats and spring rye are sometimes grown. The two last mentioned mixtures are usually used for pasture purposes only. A very heavy yielding pasture mixture is made up of peas 60, oats 34, millet 2 and rape 2 lbs. The rape should be omitted if the pasture is desired for dairy cattle.

289. Soiling Crops.—The soiling crops that are best suited to our climate and soil are, in order of their availability for use, winter rye, alfalfa (first cutting), oats or other grain crops, peas and oats, alfalfa (second cutting), corn and rape. These crops can be made to produce a succession of either green feed or pasture from early May to November. The oats, or peas and oats, and rape, may be sown as needed and can be made to provide feed at times when other crops are not at their best.

290. Fodder Crops.—The air dry roughage, other than hay, that is fed to live stock is familiarly known as fodder. It includes the straw of wheat, oats, barley, rye, flax and peas, the stems and leaves of threshed grasses, clovers and alfalfa, and dry cured corn stalks. The value of these as of all forage is determined by their composition, digestibility, palatability and succulence. The table of composition in the appendix gives the dry matter and digestible nutrients per 100 lbs. and the fertilizing constituents per 1,000 lbs., in the chief fodder crops; and the notes that follow give a brief summary of the relative suitability of the different fodders for different purposes.

291. Corn Fodder.—This is the term applied to stalks of corn, whether green or dry, from which the ears have not been removed. Corn stover is used to designate the stalks after the removal of the ears. In Western Canada corn is seldom grown for its grain, but it is often grown and the stalks fed to cattle as dry fodder. When it appears quite dry, corn contains much more moisture than hay or straw and is therefore rather more succulent than these feeds and more difficult to cure in stacks. Corn fodder is low in the proportion of crude

protein to carbohydrates. It is, therefore, a poorly balanced ration, and should be mixed with feeds rich in protein for best results. As compared with oat hay it is inferior in protein content but contains more of both protein and fat than does oat straw. The more grain the stalks contain the richer in these constituents the fodder will be. It furnishes a good maintenance ration for store cattle, and may be used as a part of the ration for carrying horses and sheep through the winter. From 15 to 20 per cent. of its dry matter as well as its protein is lost if the crop is exposed to the weather for more than a few weeks.

292. Straw and Chaff.—*"As the cereals and other plants mature, the nutrients which have been built up in the green portions of the plants are in large part stored in the ripening seed, thus exhausting the stems and leaves of easily digested nutrients and leaving in them the woody fibre, or cellulose. All straws are therefore much lower in nutritive value than the same plants cut for hay before maturity. The feeding value of each class of straw may differ widely, depending on the stage at which the crop was cut, the care with which it was cured and the amount of the more nutritious grasses and weeds present.

293. Straw and Chaff of Cereals.—*"Straw is poor in crude protein and fat, and high in woody fibre, or cellulose, a carbohydrate that requires much energy for its digestion and disposal. Accordingly it should be fed but sparingly to animals at hard work, fattening rapidly, or giving a large flow of milk. For animals at light work, fattening slowly, or giving only a little milk some straw can often be advantageously used. Straw is particularly useful in winter with horses that are idle and cattle that are being carried over without materially gaining in weight. Heat is one of the requirements of such animals, and the large amount of energy expended in masticating, digesting, and passing straw through the body finally appears as heat which helps warm the body. The stockman who understands the nature and properties of straw will usually be able to make large use of it. In Canada and Europe pulped roots and meal are often mixed with straw, which is cut or "chaffed" and the moist mass allowed to soften and even ferment slightly. It is

* Sections 292 to 294, from "Feeds and Feeding", Sixteenth Edition, by Henry & Morrison.

then readily consumed in large quantities by cattle and sheep with satisfactory results. In many districts of Europe horses are fed cut straw mixed with their concentrate allowance. When fed with corn silage, cut straw is equal to corn stover for fattening lambs.

Oat straw with its soft, pliable stems is the most nutritious, followed by barley straw. Wheat straw being coarse and stiff, is not so readily eaten by cattle, though spring wheat straw is of greater value than that from winter wheat. Rye straw, harsh and woody, is better suited for bedding than for feed. The chaff of wheat and oats contains more crude protein than does straw, and forms a useful roughage when not unduly contaminated with dust, rust or mould.

294. Flax Straw.— * "While not especially desirable, flax straw may be fed in the absence of better roughage. The statement that the stringy fibre of flax forms indigestible balls in the stomach of farm animals is unwarranted, since it is digested the same as other fibrous matter, such as the lint of cotton and the pith of the corn stalks. Green colored straw from immature flax plants should be fed with extreme caution, as it may contain large amounts of prussic acid. Ince of the North Dakota Station found that the amount of this poison in straw or chaff from ripe flax plants was so small that it could not cause trouble if fed in moderate amounts. Straw containing considerable flaxseed or weed seeds has increased value. Wilson of the South Dakota Station advises against feeding flax straw to pregnant animals."

295. Straw of the Legumes.—Field pea straw is much richer in protein than the straw of the cereals. Where peas are grown the straw is used extensively as a roughage in sheep feeding.

Alfalfa straw consists largely of stems and chaff. Both are richer than the straw from threshed grasses. The chaff has considerable value but the woody stems are *quite indigestible. What is true of alfalfa straw is* equally true of sweet clover straw. There is generally, however, some leaves and green twigs in the threshed alfalfa and sweet clover and much, if not all, of the fodder will be found useful as roughage in the winter months.

* Sections 292 to 294, from "Feeds and Feeding", Sixteenth *Edition, by Henry & Morrison.*

296. Straw from the Threshed Grasses.—When timothy, western rye grass or brome grass are cut for seed the straw is a by-product. It is much less valuable than when cured as hay, being less palatable, more woody and poorer in composition. Each has, however, some value and none should be wasted. Brome straw is the most nutritious, being more leafy and less woody. Western rye and timothy straw are more fibrous, western rye particularly being woody and unpalatable. Most growers find a use for these by-products by utilizing them with other feeds in carrying over store cattle.

297. Ensiling Crops.—*"The preservation of beet leaves, beet waste, and other green forage by gathering into heaps or into earthen pits and covering with earth has long been practised in Europe. In 1877 the French farmer, Goffart, published his "Manual of the Culture and Siloing of Maize and other Green Crops", the first book of its kind, covering 25 years of practical experience. To Goffart belongs the credit of describing the first modern silo and of observing and recommending the peculiar merits and advantages of the maize (corn) plant for silage. In 1876 Francis Morris, Oakland Manor, Howard County, Maryland, made the first silage in America by putting whole corn forage into a pit dug in the ground and covering it with earth The first silo in this country built partly above ground was constructed by Dr. J. M. Bailey, of Boston, Massachusetts, in 1879. In the same year Mr. J. M. Brown of New York, gave American readers a translation of Goffart's book, and in 1880 Dr. J. M. Bailey issued "The Book of Ensilage, the New Dispensation for Farmers." In 1881 Professor I. P. Roberts at Cornell University, and the senior author at the University of Wisconsin, built and filled the first silos used for experimental purposes in America. By these means silos and silage were brought prominently before the farmers of this country, and the interest which was awakened has steadily increased until the ensilage of fodders has become a factor of vast importance in American Agriculture."

298. How Ensiling Preserves Forage.—*" When green forage is packed firmly into an air-tight chamber, such as a silo. fermentations take place, caused both by the enzymes contained

* Sections 297 and 298 from "Feeds and Feeding", Sixteenth Edition, by Henry & Morrison, through courtesy of the authors.

in the plant cells and by bacteria and yeasts carried into the silo on the forage. During these fermentations much of the sugar in the ensiled forage is broken down into organic acids, chiefly lactic acid (the acid of sour milk), with some acetic acid (the acid in vinegar), and traces of other acids. In these changes oxygen is taken up and carbon dioxide (carbonic acid gas) given off. At first the oxygen in the air which has been entrapped in the ensiled mass is used up, but if the mass has been well compacted this is soon exhausted. The enzymes and bacteria then obtain the additional oxygen needed for these decompositions from the oxygen-containing compounds in the forage—chiefly the sugars. When the sugar in the forage has been changed into the acids the fermentation is checked, for the other carbohydrates are attacked to only a small extent. It is due to this that well matured corn or sorghum makes less acid silage than immature plants, which contain more sugar. Even though an excess of sugar is present the

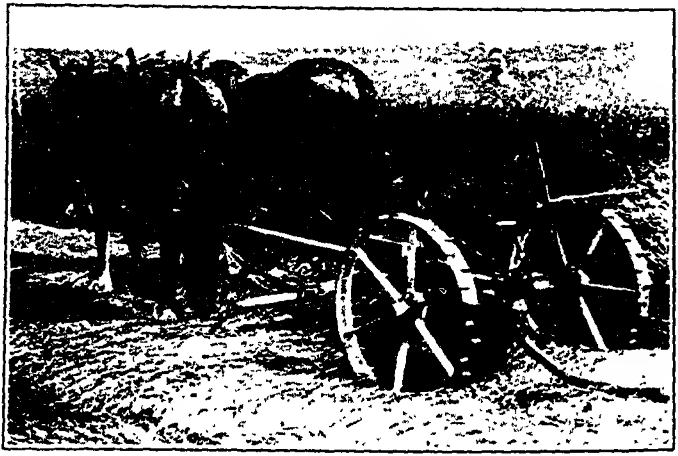

Fig. 109.—Cutting Native "Slough" Hay on Overflow Land.

fermentation comes to an end at length, for sufficient acid is finally produced to prevent both the further growth of the bacteria and yeasts and the action of the plant enzymes. During the fermentation processes the temperature rises somewhat, but if the mass has been well compacted, so that but little air is present, the temperature in the interior of the silo rarely reaches 100 degrees F. The changes are therefore far less extensive than those which occur in the making of brown hay.

"Not only does the accumulation of acid automatically check further action of the acid-forming enzymes and bacteria, but it also prevents the growth of undesirable putrifying bacteria, such as cause the decaying of meat. The poor-quality, foul-smelling silage which often results when such legumes as alfalfa, clover, or soybeans are ensiled alone is doubtless largely due to the fact that there is not enough sugar present in the plants to yield sufficient acid to check the growth of these putrifying bacteria. The high protein contents of these plants also favors putrefaction.

"After a few days the silage-making processes cease, and no appreciable changes will take place so long as the air is excluded. Instances are on record where silage made 12 to 14 years has been found to be of excellent quality."

299. Requisites of a Good Silo.—A good silo should have air tight perpendicular and strong walls, should be deep and preferably cylindrical in form. It may be made of wood, concrete, brick, stone or sheet steel, or it may be a "pit" silo either lined or unlined.

300. Advantages of Silage.— *"The widespread use of the silo for the preservation of forage is easily explained when we consider the advantages this system offers, the more important of which are:

1. At a low expense silage furnishes high quality succulent feed for any desired season of the year.
2. When crops are properly ensiled less of the nutrients are wasted through the fermentations which take place than are lost when the forage is cured as hay or dry fodder.
3. Silage, even from plants with coarse stalks, such as corn and the sorghums, is eaten practically without waste.
4. Crops may be ensiled when the weather does not permit of curing them into dry fodder.
5. Weedy crops which would make poor hay may make silage of good quality, the ensiling process killing practically all the weed seeds present.
6. The product from a given area can be stored in less space as silage than as dry forage. . . . ."

301. Crops for the Silo.—*"Where it thrives Indian corn is the best silage plant. In England meadow grasses have been converted into stack silage, in which case the decaying outside protects the interior of the mass—a practice which, however, is not gaining favor. Potts of Australia, reports that three tons of grass silage is estimated to be worth one ton of oat

* Sections 300 and 301 from "Feeds and Feeding", Sixteenth Edition, by Henry & Morrison.

hay. A stack containing 200 tons of grass silage, opened after ten years, furnished good feed. Georgeson of the Alaska Experiment Station reports that fresh native grasses kept well when stored in a log silo made smooth inside; and that such silage satisfactorily maintained oxen during three winters.

"Green cereals are fairly satisfactory for silage, providing they are ensiled before the stems have become woody. Since the hollow stems of these plants contain air, such forage must be closely compacted in the silo.

"As a class the legumes have proved disappointing for silage when ensiled alone. Better results have been secured when

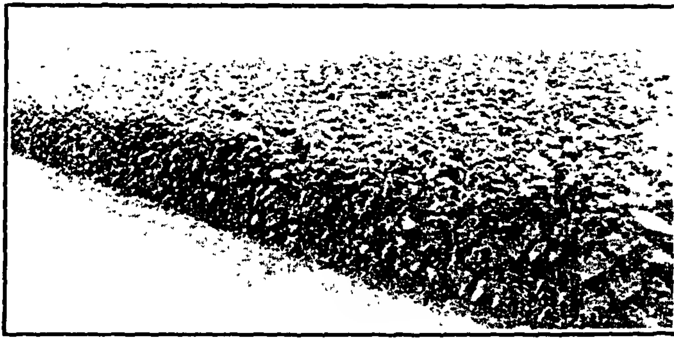

Fig. 110.—Sunflowers Grown for Ensilage.
This crop has averaged over twice as much fodder as corn in Saskatoon during the last five years.

such crops as alfalfa and clover are ensiled with plants which carry more sugar and less protein, such as rye, wheat, corn or sorghum. Except where weather conditions prevent curing these legumes into satisfactory hay, there is usually little need of ensiling them, for more reliable silage crops may usually be grown. When ensiled with corn or the sorghums, cowpeas and soybeans produce silage of high quality, rich in protein.

"Weeds and other waste vegetation may sometimes be advantageously ensiled. Featherstonhaugh of Australia, reports a case where 800 tons of ensiled thistles made satisfactory silage. Attempts to ensile cabbage, rape and turnips have failed, the product being ill-smelling and watery."

Recent reports from the Montana Station indicate that sunflowers are being satisfactorily ensiled, and that the ensilage is giving very good results in practical feeding trials. This is a very heavy yielding crop, usually producing more than twice as much as corn under our conditions. Sunflowers withstand

greater extremes of climate than corn and appear to be quite free from insect and disease pests. If the crop can be satisfacortily utilized as silage it should aid in solving our feed problem. When grown for silage sunflowers are sown during the last week of May in rows three feet or three and one-half feet apart at eight to ten pounds per acre, or planted in hills three feet or three and one-half feet apart at five to eight pounds per acre. Both the intertillage and harvesting procedure is similar to that for corn for silage.

302. The Relative Value of Different Forage Crops.— The acre yield of a crop is not a sufficient guide to its usefulness for the reason that the figures given may include as little as 10 per cent. or as much as 95 per cent. of water.

The acre yield of dry matter is a better guide but it is not satisfactory because it gives no indication of either the quality or composition of the crop or the amount that is "digestible."

Even when the dry matter yield, the composition and the digestibility are given, the lack of palatability may be a sufficient cause for discarding the crop.

Total yield, yield of dry matter, composition, digestibility and palatability are all important and each must be considered before one can intelligently determine the forage crops he will use. But in these days of strong competition the purely economic factors are claiming an ever increasing consideration. The cost of production is chief among these.

It is not enough to know the cost of producing an acre of a given crop, neither is it enough to know the cost of producing a ton of dry matter, although this is much more valuable information than the acre cost. Nor yet is it a sufficient guide to know the cost of producing a definite amount of digestible dry matter, for the reason that the digestible dry matter consists of different nutrients, each of which has a different value. The

value of the different nutrients in a forage crop varies with different classes, ages and conditions of the animals to which it is fed, and it is not, therefore, possible in the space available to give more than relative general values to them.

At the present time the best guides to the relative value of the different forage crops for western conditions are:

1. The relative cost per pound of the total digestible nutrients they contain, and

2. The relative cost per unit of heat or energy value they are capable of producing.

The following table, based on the average yield of the different crops at Saskatoon, gives this data for Central Saskatchewan conditions:

Crop	Cost per 100 lbs. of Digestible Nutrients.	Relative cost per unit of energy value (100,000 calories).
Oats	$ .49	$ .64
Peas and Oats	.57	
Millet	.50	.66
Winter rye	.51	
Sweet Clover	.60	.90
Corn	.99	1.21
Corn as ensilage	1.52	1.51
Turnips	1.68	
Swedes or Ruta bagas	1.34	1.80
Mangels	1.62	1.86
Rape	.44	.50
Alfalfa	.66	.98
Western rye grass	.65	
Brome grass	.65	
Timothy	.76	1.13

The above data indicates:

1. That annual crops for forage can be more cheaply grown under the conditions where tested than perennial ones.
2. That the digestible nutrients in oats were produced more cheaply than those in any other crop except rape for which there was no charge made for harvesting since it is ordinarily pastured off.

3. That the cost per unit of energy agrees approximately with the cost of digestible nutrients.
4. That the digestible nutrients as well as the energy in root crops and corn (the former particularly) are very expensive.

The following facts should, however, be kept in mind when interpreting these figures:

1. That the nutrients in alfalfa, sweet clover and peas are more valuable, pound for pound, than those in any of the other crops.
2. That the legumes (alfalfa, sweet clover and peas) leave the soil richer in nitrogen than the other crops and that the perennial grasses leave the soil richer in root fibre than any of the annual crops.
3. That the food value of the succulent crops—roots and ensilage—is not fairly expressed in the above table because these crops (1) improve the health of the animals in winter, and (2) increase the palatability and digestibility of other coarse fodders in addition to providing the digestible nutrients the cost of which is computed above.
4. That the corn crop leaves the soil richer in moisture and available plant food than any of the others.
5. That the relative yields of these different crops vary under different soil and climatic conditions and that the figures here reported are not therefore conclusive for all areas even in the prairie section.

303. Grades of Hay.—The grades for hay grown in the provinces of Manitoba, Saskatchewan, Alberta, British Columbia and the North West Territories are defined as follows in Bill No. 20, passed by the House of Commons in 1918.

304. Grades of Tame Grasses for Hay.—

(a) Choice Timothy Hay shall be timothy free from stubble or weeds, with not more than one-twentieth other grasses, of bright natural color and properly cured and sound;
(b) No. 1 Timothy Hay shall be timothy with not more than one-eighth mixed clover or other tame grasses, and not more than one-twentieth weeds, properly cured, of good color and sound;
(c) No. 2 Timothy Hay shall be Timothy with not more than one-fourth clover or other grasses, and not more than one-tenth weeds, of fair color and sound;
(d) No. 3 Timothy Hay shall include all hay showing at least one-half timothy not more than one-fifth weeds or inferior grasses and must be sound.

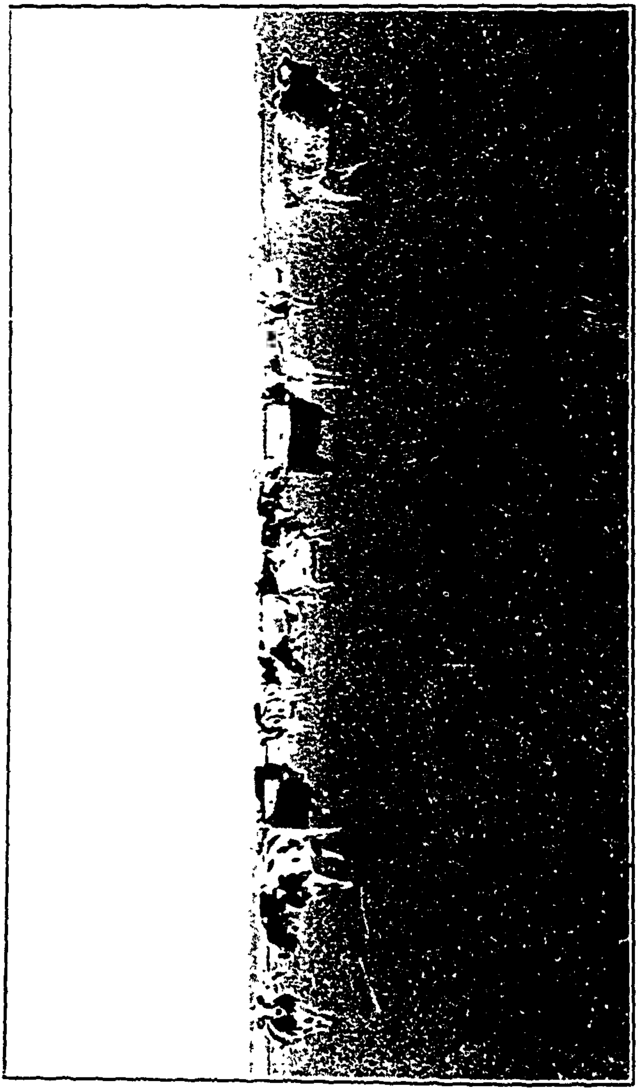

Fig. 111.—Herd on Mixed Pasture.

(e) No. 1 Timothy Clover Mixed shall be timothy and clover mixed with at least one-half timothy and the remainder good clover, of good color and sound:
(f) No. 2 Timothy Clover Mixed shall be at least one-third timothy, one-third clover with not more than one-tenth weeds and the remainder of mixed tame grasses, of fair color and sound.
(g) No. 1 Rye Gass, Brome, Orchard Grass or Alfalfa shall be rye grass, brome, orchard grass or alfalfa as the case may be, with not more than one-eighth of other poorer classes and not more than one-twentieth weeds, properly cured, of good color and sound:
(h) No. 2 Rye Grass, Brome, Orchard Grass or Alfalfa shall be rye grass, brome, orchard grass or alfalfa, as the case may be, with not more than one-tenth of other poorer grasses, and not more than one-tenth weeds, of fair color and sound;
(i) No. 3 Rye Grass, Brome, Orchard Grass or Alfalfa shall include all hay showing at least one-half Rye Grass, Brome, Orchard Grass of Alfalfa, as the case may be, and not more than one-fifth weeds or other poorer grasses and must be sound.
(j) No Established Grade shall include all hay not classified in the foregoing.

305. Grades of Wild Grasses.—

(a) Choice Prairie Hay should be composed of seventy-five per cent. Red Top, Blue Joint or Peavine hay or a mixture thereof, of bright color, dry, well cured, sweet and sound, free from weeds and other objectionable matter;
(b) No. 1 Prairie Hay shall be any one or a mixture of the following: Red Top, Fescue, Bunch, Buffalo, Wheat and Rye grasses with not more than one-quarter Peavine or Wild Vetch, all dry, well cured, of good color, sound and reasonably free from weeds or other objectionable matter;
(c) No. 2 Prairie Hay shall include any one or a mixture of the grasses mentioned in "No. 1 Prairie Hay" with not more than one-quarter Peavine or Wild Vetch; all dry, of fair color, well cured, sweet, sound, and reasonably free from weeds or other objectionable matter;
(d) No. 3 Prairie Hay shall be any one or a mixture of the grasses mentioned in "No. 1 Prairie Hay", of fair color, and may also contain Slough or "Scotch" grass of good color, dry, not caked, and reasonably free from weeds and other objectionable matter;
(e) No. 4 Prairie Hay shall be Slough grass or Sedge of fair color, not too coarse, dry, sound and reasonably free from weeds and other objectionable matter.

306. No Grade or Rejected Hay.—

(a) No Grade Hay shall include all hay that is damp or otherwise unfit for storage, and shall be entered in the inspecting officer's books as "No Grade" with a note as to its quality and condition.

(b) Rejected Hay shall consist of hay containing more than twenty-five per cent. of Foxtail or Spear grass, or hay heated or containing must or mould or otherwise damaged, and shall include all hay not good enough for other grades.

307. Grades of Straw.—The grades of straw shall be as follows:

No. 1 Straw shall be bright, clean, well saved oat straw, suitable for feeding purposes;

No. 2 Straw shall be long straw from all cultivated cereals, sound and fair in color;

No Grade Straw shall include all straw, short and chaffy but sound.

CHAPTER XI

ROOT CROPS

"Nature's Provision for the Health of Stock in Winter."

The so-called "root" crops include those species of plants the enlarged upper part of the roots of which is used as stock or human food or for the production of sugar. The most important roots for feeding are the swedes or swede turnips, mangels, sugar mangels, fall turnips and carrots. The "root" commonly grown in some countries for its sugar is the "sugar beet".

The root crop is as yet, and probably will continue to be, of minor importance in the West but as the live stock industry increases in the north the need for succulent winter feed will probably result in an increased acreage devoted to this crop. At the present time the relative value of the root crop as compared with wheat is 1½ per cent. in Manitoba, 2 per cent. in Saskatchewan, and 2½ per cent. in Alberta, the average annual value for the three Prairie Provinces previous to the war being 2½ million dollars as compared with 127 million dollars for wheat. In Manitoba the root crop exceeds in value that of alfalfa, rye and peas. In Saskatchewan it is reported to exceed the value of "hay and clover", corn, alfalfa, rye and peas, while in Alberta its value is greater than that of any of alfalfa, corn, rye or peas.

308. Advantages of Roots.—The chief advantages to be derived from the use of roots as stock feed results from the succulence they add to the ration. The air-dried forage commonly used is worth more, pound for pound.

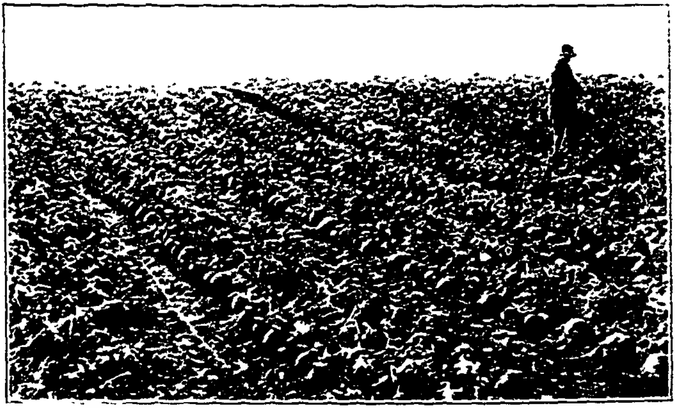

Fig. 112.—Topping "Swedes."

than an equal weight of the same or other crops in the green condition. Yet the latter is of very much greater value than the former as a corrective of physical ills. Succulence in the winter feed not only improves the health of animals and lessens the percentage of losses, but increases the palatability and digestibility of coarse fodders and lowers the cost of beef and milk production.

Root crops which retain their succulence when stored, or other crops, such as corn, when preserved in the green state by ensiling, must furnish this succulence. Corn is not well suited to the northern parts of the West and no other silage crop has yet established itself there, although oats, and peas and oats promise much, and the use of sunflowers is a possibility. Unless a suitable silage

crop is found, roots will necessarily be grown if succulence is to be a quality of the winter feed in this area.

309. Difficulties of Root Growing.—The chief objection to growing roots in the West is the labor cost. The development of labor-saving machinery for thinning and

Fig. 113.—Three Types of Mangels.
Showing (1) globe, (2) intermediate, (3) long

harvesting has not kept pace with the development of the machinery used in growing other crops, hence the necessity for using more labor per unit of production; and since labor is relatively higher in price than any of the other factors of production, the increase in the root acreage has not been as great as that of most other crops.

Other minor difficulties are the danger from the soil drifting before the plants are well established, occasional losses as a result of cutworms, the conflict of harvesting with grain threshing operations and the relatively low yield in the drier parts. Another disadvantage, although not a serious one, because the root acreage is necessarily small, is the relatively low yield of grain

crops after swedes or turnips as compared with that after corn, potatoes or the fallow.

310. Classes of Roots.—The relative value of the different classes of roots is determined chiefly by the yield, keeping quality and dry matter content although resistence to spring and fall frosts, suitability for specific purposes, and ease of growing and harvesting, must also be considered.

311. Swedes or Swede Turnips are heavy in yield and high in quality. They are slow in growing but quite resistant to frosts in the fall, and keep well during winter. Swedes prefer rich black soils, well supplied with moisture. They do better than most other roots on heavy soils. Unless fed just after milking they give an undesirable flavor to milk and butter. For this reason they are chiefly fed to fattening or store cattle and to hogs and sheep.

312. Turnips.—Sometimes called fall turnips, soft turnips or white or yellow turnips—are heavy yielders, quick growers, poor in quality and poor keepers. They too resist fall frosts well and, like swedes, may affect the flavor of dairy products. They can only be recommended for late seeding and for fall feeding.

313. Mangels produce heavy yields of good quality, particularly for milking cows. The dry matter content is lower than swedes, but higher than turnips. These do not give an undesirable flavor to dairy products. In this climate they do best on dark alluvial soil. They are thought by some to be more productive than swedes under dry conditions. When "topped" and harvested carefully they keep well, but under average conditions in the West they should be fed before the swedes.

314. The Sugar Beet is very little grown for forage, and for sugar only in the irrigated areas of southern Alberta. It is low in yield though high in quality and dry matter.

315. Sugar Mangels, or Forage Sugar Mangels, include several types which range in character from typical

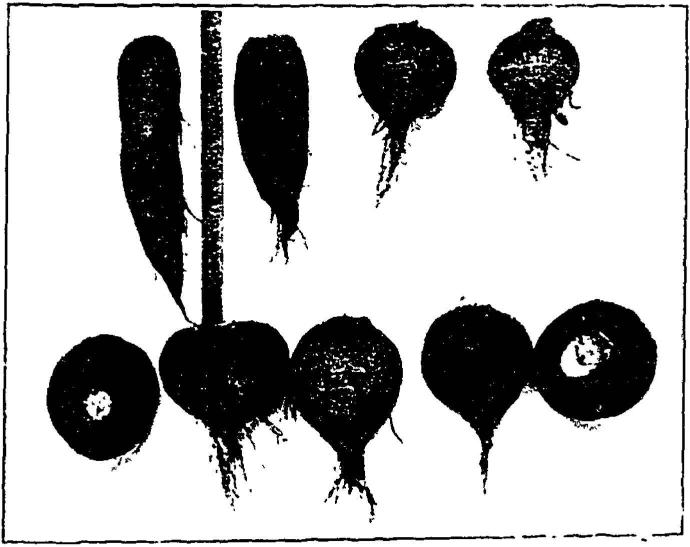

Fig. 114.—Several Types of Swedes and Turnips.

mangels to what might be called high yielding, low quality sugar beets. They are generally less productive than mangels but usually higher in dry matter and in quality. They are favored by many for dairy cattle and as a winter succulent for hogs.

316. Carrots are low in yield, high in dry matter content, high in quality and quite good keepers. They are not likely to be found profitable, except where horses are

kept on dry, coarse feed during the winter. Under these circumstances a few carrots will keep them healthier and often avoid losses. Carrots prefer rich black soils, but do well on loam types if the moisture supply is ample.

317. The Choice of Varieties.—Many tests of different varieties of roots are conducted every year at the different experimental farms. Since the seed has had to be purchased and is not therefore necessarily of the same quality and from the same strain from year to year these tests are not as conclusive as one could wish. Nevertheless, the superiority of a few types has evidenced itself in most of these tests. Among swedes those of the "globe" type have done well, while the "intermediate" mangels and carrots are generally found to do best.

Fig. 115.—White Intermediate Carrots.

Some of the varieties commonly recommended are,—

Swedes—Magnum Bonum, Bangholm, Good Luck, Perfection, Champion and Canadian Gem.

Turnips—Imperial Green Globe, Aberdeen Purple Top, and Greystone.

Mangels—Danish Sludstrup, Yellow Intermediate, Yellow Globe and Yellow Ovoid for average soils; White Sugar Mangel and Mammoth Long Red for deep soils; and Golden Tankard for shallow soils.

Sugar Mangels—Royal Giant and Rosy Sugar Mangel.

Sugar Beets—Klein Wansleben and Vilmorin's Improved.

Carrots—White Intermediate. White Belgian and Mastadon.

New Canadian bred strains of some of these crops have been developed at Ottawa. Guelph. MacDonald College. and the University of British Columbia. and as seed of these becomes available it will probably be found more reliable than that introduced from other countries.

318. Soils for Roots.—In the prairie areas. where lack of sufficient moisture is generally the cause of low yields of roots. the soil found to be best suited is that in the lower levels of rolling land or adjacent to, or in sloughs that are free from alkali and that have been drained. This type of soil supplies at once the large moisture and plant food requirements of root crops.

Where such land is not available the deepest and richest soils should be chosen particularty for mangels and sugar mangels. Swedes do well on heavy types of soil that are rich and in good tilth. Carrots may be grown to perfection on lighter soils if well supplied with available plant food and moisture. Turnips do well on different soil types if the moisture and available plant food supply is satisfactory.

319. Preparation of the Land.—Fallowed land or corn ground is ordinarily much to be preferred to sod land

for roots in this climate. The only objection to the use of the fallow is the possibility of the soil drifting before the plants become established. Sod land is the freest from weeds but is often too dry and lumpy for good

Fig. 116.—A Field of Swedes.

germination. Fall or spring plowing is advisable for roots only in the most moist areas. A good practice that is developing in the open plains area is to plant the roots in the "snow trap" or strip of land between the outer and inside rows of the shelter belt. This area is generally only a few rods wide but may be made much wider and a considerable length. Such an area is always well supplied with moisture and protected from the wind and invariably gives excellent yields.

Unlike the grain crops which require to ripen before fall frosts if the highest yield and quality are to be ob-

tained, roots do not suffer with the first frosts and actually grow considerably after grain crops are harvested in the fall. Because of this fact there need be no fear of overfertilizing land intended for roots providing the manure is well rotted before application or preferably well rotted after application and before the roots are sown. Manuring before plowing the fallow or before a corn crop, either of which may be followed by roots, is a good practice. This gives the manure time to decay and leaves it well incorporated with the soil.

On many types of soil in humid areas commercial fertilizers pay well with roots. In the few tests under western conditions that have been reported it has not yet been shown that they more than pay their way.

Whatever the preparation it is important (1) that the land be well stored with moisture and available plant food, (2) that it be free from grass, (3) that it be firm to quite near the surface and (4) that every precaution be taken to keep the surface soil from blowing.

320. The Time to Sow.—The root crop in the prairie provinces is ordinarily put in about the last week in May or the first week in June. This is the result of pressure of other work earlier in the spring and not because it is thought to be best. On well prepared land at Saskatoon the largest yields have been secured from seeding carrots the first ten days of May, swedes the 10th of May and mangels between the 10th and 20th of May. There is some danger of loss from spring frosts after seeding this early, but as a rule these crops do not take serious injury even from quite severe frosts in spring. The average yield of swedes for the three years, 1915, 16 and 17, dropped off 20 per cent. for every ten days delay

in seeding after the 10th of May and up to the 10th of June. The average yield for the earlier date being over 30 tons, and for June 10th only slightly over 11 tons per acre. Considerably earlier seeding than is commonly

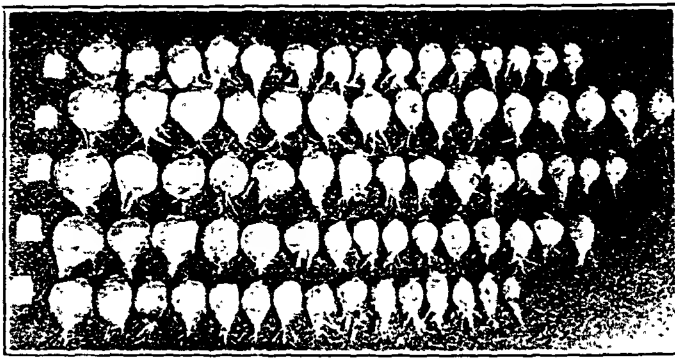

Fig. 117.—Relative Yields From Sowing Swedes at Different Times. Dates of seeding, first row, (top) April 30; second, May 10; third, May 20; fourth, May 30; bottom, June 10.

practised is advisable with roots. The second and third weeks of May are much to be preferred over later seedings as a rule.

321. The Amount to Sow.—The possibility of soil drifting, injury from spring frost or cutworms and poor germination of the seed, all emphasize the necessity for more seed than is commonly sown. When the rows used are 30" to 32" apart the following amounts should be used:

Swedes .... 4 lbs. per acre.
Turnips .... 3 lbs. per acre.
Mangels, Sugar Mangels and
Sugar Beets .... 12 to 15 lbs. per acre.
Carrots .... 4 lbs. per acre.

These quantities, if all the seed grows, will place the seeds several times closer than the plants are desired, but a few ounces of seed is much less costly than a patchy stand, besides the risk is greater when less seed is sown, and the use of the harrow to save man labor in thinning is not so satisfactory as in a thicker stand.

322. Methods of Seeding.—Any one of three methods of seeding may be used—the garden drill, the turnip seeder or the grain drill. The garden drill is advisable

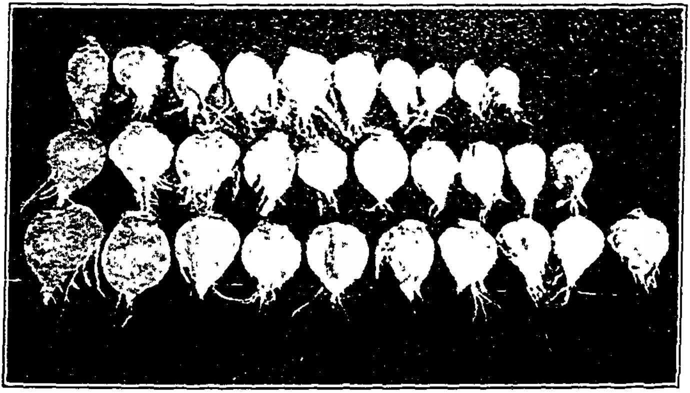

Fig. 118.—Relative Yields With and Without Ridges.
Top row, sown on high ridges; middle row, on medium ridges, and bottom row, sown on the flat, at Saskatoon

only in small areas; the turnip seeder is more suited to seeding in raised drills and has not actually come into general use in the West; the grain drill with a grass seeder attachment and press wheels behind is the most economical of time and on well-prepared, firm soil gives good results. If the grain drill is used for mangels the seed should be placed in the grain box. Swede and turnip seeds feed quite satisfactorily through the grass

seed box, and carrots with a little care may be sown from this box also.

The practice of seeding on raised drills, as commonly followed in the east and in Europe, is not wise in this climate. The drills dry out too much, the germination of the seed is poorer, the stand less satisfactory and the yield lower when sown on ridges than when sown on the flat. The advantage of ease of thinning and hoeing the roots on the ridges is more than offset by the possibility of lessening the hand labor by cross harrowing of the land sown on the level after the young plants are up.

323. Thinning and Singling Roots.—Swedes, turnips and mangels when sown in the ordinary way come up too thickly to return the largest yield of "roots" or to be harvested satisfactorily. Consequently thinning is necessary. The old plan was to "block out" the rows with a hoe, leaving a number of plants in a group to be "singled" at a later time after some additional growth. A more recent development is the use of the light lever harrows crosswise of the rows after the plants are up. If done carefully, on well-prepared land having a uniform stand, this will thin carrots satisfactorily, and will lessen the necessity of "blocking out" the other classes of roots. If the stand is uneven and harrowing therefore less advisable, the carrot rows may be thinned with an iron rake having sharp pointed teeth. This very materially lessens the labor and thereby the cost of root production.

When thinning the larger roots after harrowing or singling them after "blocking out", the largest and most vigorous plants should be left. The sooner they can be thinned after the third true leaf appears the better the plants will develop. It frequently happens, however,

that cutworms or other insects, or whipping by the wind, reduces the stand. In view of one or all of these possibilities rather later thinning is to be preferred.

Swedes, turnips and mangels should be thinned to about 8" to 10" and carrots to 1" apart. Swedes and turnips are sometimes given more room, but in our short growing season the closer planting is to be preferred, although the individual roots from such planting are smaller.

324. Cultivation of the Root Crop.—Given a well-prepared soil, a good stand of roots, two or more careful cross harrowings after the plants are up, and one or two cultivations with intertillage machines early after thinning, the root crop will need little added cultivation except on weedy land. Weeds must be controlled at any cost in the early stages of the crop's existence. The vigorous growth and large spreading leaves of all root crops, except carrots, tend to keep down these pests, once the crop gets a good start. The prevention of weeds in the root patch should be aimed at rather than the control of them after they start. To prevent weeds getting a start until the leaves shade the rows, should ever be kept in mind by the root grower.

325. Harvesting Roots.—All root crops withstand quite heavy fall frosts and grow considerably in the month of September. For this reason and because of necessary work in connection with the grain harvest, taking up the roots is usually delayed until early October. To take them up before this date means greater shrinkage and poorer keeping, while if left longer, cold, backward weather or snow or an early freeze-up may cause great inconvenience and loss. They cannot safely be left in the ground after the 10th of October.

Mangels should be taken up first, since they suffer more from frosts than swedes, turnips or carrots. They should be pulled and the tops removed carefully by

Fig. 119.—Plowing Out Turnips after Topping.

hand. If injured in topping or harvesting they "bleed", and injured mangels are much more subject to decay than uninjured ones.

Carrots are generally topped by hand and they may be pulled by hand also if a furrow is plowed with a mouldboard plow, the landside being run close to the row. Swedes and turnips are ordinarily topped with a hoe, two rows at a time, leaving the tops in every other division. The roots may be lifted by a broad-share walking plow having the coulter removed, by a potato digger or by a turnip hook. The plow is generally preferred although all three methods are in common use.

326. Storing Roots.—Less attention has been given to the preparation of suitable storage places for roots in

the West than to most phases of root production. Yet more losses occur through inadequate protection from frost and through heating or too low humidity in the storage room than occur through failures in production.

Pits are frequently used for a while in the fall and in some cases for all winter storage. For the latter purpose they must be dug well below ground and well protected by several alternate layers of soil and straw.

The greatest success in pitting has been obtained (1) where the pit is sufficiently deep to keep the top of the pile of roots well below the level of the ground and (2) where the protecting cover of straw or manure and soil is not only thick but also well spread out and thoroughly packed against the surface of the ground at the sides of the pit. The frost usually penetrates the pit through the more or less open spaces between the ground and the pit covering rather than directly through the latter. By making the pit cover wide and tramping it well against the surface soil at the sides and ends, and by doing this preferably when the soil is not frozen the pit will be made the most secure against frost.

After filling such a pit a few rails may be laid across the top, then a layer of straw and another of soil, each about eight inches thick, the latter open at the top for ventilation. Later in the season a ventilator, with a board across the bottom to prevent the condensed moisture dropping on the roots, should be placed in the pit every six or eight feet. The layer of soil over the top should be completed, and two more layers of straw and two of soil should be added. These layers should each be at least one foot thick.

A bin in a basement barn that is sufficiently well constructed to keep the manure from freezing hard is quite

satisfactory. A cheaply constructed semi-permanent or permanent root house may be dug near the barn and a stairway opening into the feed alley provided. Mr. W. A. Munro, of Rosthern, Saskatchewan, who has used such a storage place with quite satisfactory results, has

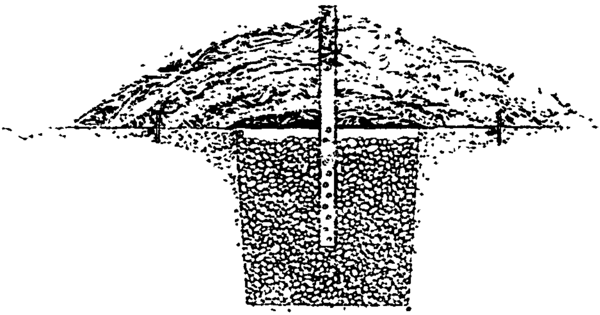

Fig. 120.—Earth Pit for Roots or Potatoes.

Showing precautionary provisions for protection against frost. Note (1) contents below level of the surface of the ground; (2) four layers each of straw or manure and soil (3) these layers extend at least six or seven feet beyond the sides of the pit and are well tramped against the surface soil (4) frost board and (5) ventilator plugged with straw or sacking after severe weather sets in

published a plan of his root house, which any one may get on application. Whatever the plan of the storage it is important that the temperature be kept as near freezing as possible and yet not freeze. In early fall the store room should be kept closed in daytime and opened at night, while in cold weather the ventilators should all be closed during the periods of lowest temperature. The room should not be let get too dry nor yet too damp. The former causes a serious shrinkage of the roots and the latter encourages decay. A good system of ventilation is also essential and an earthen floor is to be preferred over a wooden one.

327. Feeding Roots.—Roots are ordinarily prepared for feeding by pulping. This lessens the risk of cattle choking on the small roots and gives better results where some are frozen. It adds, however, to the labor and cost of the feed and under some conditions has been found not only to be unnecessary but to result in less milk than when fed whole. As a rule the pulping of swedes and turnips is advisable where old animals are being fed as well as where small roots or frozen ones are used. With hogs and sheep fed in a warm place there is less need of pulping. Mangels may be fed either pulped or whole, the arguments for pulping being less convincing for these roots than for swedes.

CHAPTER XII.

POTATOES

The Cheapest Human Food.

The potato crop occupies a position of relative unimportance as compared with grain crops in Western Canada, yet its use is so universal and its future so promising that the important points in connection with its culture should be well understood by all growers.

Potatoes, in this country, are used almost altogether for human food. As yet none have been used for making starch or alcohol and only the unmarketable ones and the small surplus above the needs of the family have been used as food for stock. Up to the present time the chief market outside the farm has been the village, town and city homes, mostly within our own boundaries.

328. Advantages of Potato Growing. — When given suitable soil conditions the potato is very productive. Yields ranging from 70 to 800 bushels per acre have been produced in many parts of the West in different seasons. The average for the leading varieties under test at different experimental farms in the West for the four years, 1912 to 1916, was between 300 and 400 bushels of marketable tubers per acre. The average acre yield on the farms of the three Prairie Provinces for the seven years, 1910 to 1916, is 157 bushels for Manitoba, 155 for Saskatchewan and 162 for Alberta.

The potato furnishes the cheapest food the gardener can grow. When one considers that from 15 to 20 per cent. of the total yield is starch, or, in other words, that

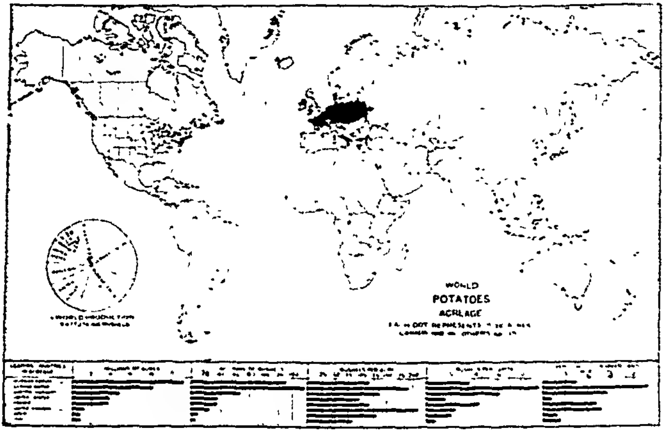

Fig. 121.—Distribution of World Acreage of Potatoes.
By courtesy Finch & Baker.

a 200 bushel potato crop contains between 1,800 and 2,400 pounds of starch, the value of this crop forces itself upon one's attention.

The potato is an "intertilled" crop and, being such, leaves the land in much better condition for grain than any other crop, with the exception of corn. Potato ground has produced nearly as high yields of grain as good summerfallow and much higher yields than land that in the previous year carried any cereal crop.

329. Difficulties in Potato Growing.—The production of potatoes presents fewer difficulties than that of most crops. Drought can generally be guarded against by thorough fallowing and planting in wide rows. Spring frosts often cut down the tops and thus lessen the yield.

but they seldom kill the plants, unless the planting has been done very early. Fall frosts sometimes come before the plants are mature, thus lessening the yield and lowering the quality of the tubers for cooking purposes. Insect damage is generally negligible, and but few of the potato diseases that have done so much harm in older countries are found. Potato scab is, however, generally present and certain other less familiar but more harmful diseases, which are treated separately (Chapter XV) and which should be better understood, are frequent causes of low yields. Our comparative freedom from fungous diseases, such as early and late blight, is a condition that we should appreciate. Every effort should be made while the soil is clean to keep it so.

330. History of the Potato.—*The potato (*Solanum tuberosum*) is an herbaceous perennial belonging to the Solanaceae or Night Shade family, a large order containing 800 or more species, of which only a few are tuber-bearing. The cultivated potato is a native of the elevated parts of Chili, Peru and probably Mexico. It is believed that the potato was introduced into Europe first from America by the Spaniards during the latter part of the 16th century. In 1586, a few years later, Sir Walter Raleigh or some of his colonists brought it from America to Ireland. The tubers were planted on Sir Walter Raleigh's estate at Youghal, near Cork, and the cultivation of potatoes extended from this place among the poorer Irish classes and also in England. In 1663 the Royal Society of England endeavored to encourage the growth of potatoes as a cheap food in case of famine.

* From Dominion Experimental Farm's Bulletin No. 90 on "The Potato in Canada", by W. T. Macoun.

but at that time the crop was not highly regarded. It was not recognized generally as an article of food for man until the middle of the 18th century, or nearly 175 years ago, when a famine in Scotland in 1743 brought it into prominence as a cheap food and gave a great impetus to its cultivation. European countries had been just as slow to recognize the merits of the potato, for it was not until 1771, when a prize was offered in France for the discovery of a food that could take the place of wheat in case of famine, that the potato came into prominence in that country. Parmentier, an apothecary, who brought forward the potato, was rewarded by the gift of 50 morgen of land from Louis XVI. During the 19th century the popularity of the potato increased rapidly in the United Kingdom and Europe, and the production increased in proportion.

"In America the settlers used the potato to some extent for food during the 17th century, and as its value became appreciated it was grown in ever increasing quantities." It has steadily improved in size and quality since that time. This improvement has been brought about by the development of new varieties from the best of the old ones and by better methods of cultivation.

331. Suitable Soils for Potatoes.—For potatoes a deep, rich, friable loam, well supplied with organic matter, is to be preferred. The medium to light types of loam soils often produce the best quality and the earliest crops. The heavy clays frequently produce large yields of more watery tubers. On soils inclined to alkalinity more scab develops, while on the sandy loams the cleanest tubers are found. Most of our normal soils under good management are well suited to potato production.

332. Climatic Preferences.—The potato prefers a cool, moist, cloudy and temperate climate with plenty of precipitation and a fairly long growing season. The eastern, northern and foothill prairie areas and the park belt enjoy the best potato climate, but the growing season is sometimes rather too short for perfect maturity. The dry parts of the prairie enjoy the longest growing season but the high temperatures of July and August, particularly when they occur in protracted spells of dry weather, are unfavorable to good yields. The chief injury done by frost in the north is to the quality rather than to the yield of potatoes, while the hot, dry weather has exactly the opposite effect. The latter can be offset only by having a good supply of moisture in a fertile soil, by thinner planting and by better cultivation.

333. Preparation of the Land.—A fallow often gives the largest yield, but generally the lowest quality. Corn ground or breaking done the year previous gives good yields, results in earlier ripening, and the tubers are generally more mealy than if grown on fallow. This applies more to heavy than to light land. Fall or spring plowed stubble is sometimes used for potatoes but it is very much less productive and, in dry years, yields very small returns. If the fallow or corn ground or breaking is firm, the condition desired for wheat, it is better to plow the land or plow in the potatoes. Potato ground should be fairly loose to a good depth and yet firm enough to prevent drying out. In hard soils misshapen tubers usually develop. Barnyard manure applied to the fallow and plowed under, or applied before corn when the latter precedes potatoes, is an excellent practice. Well rotted manure applied thinly and plow-

ed under also gives good results. Fresh horse manure, particularly if it is applied in large quantities or in close contact with the tubers is reported to encourage potato scab. If manure is to be applied immediately

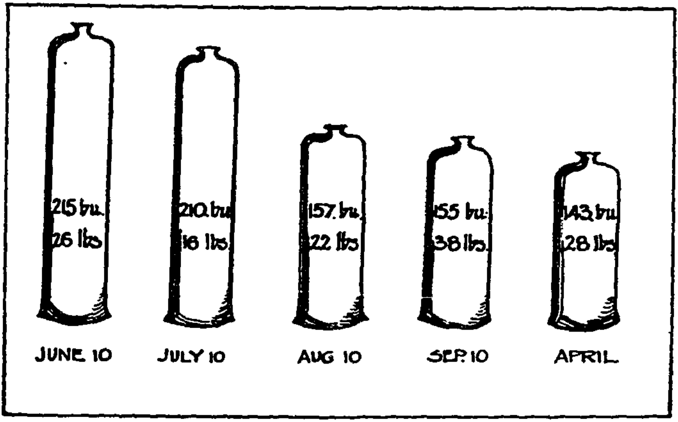

Fig. 122.—Effect of Time of Breaking on Potato Yields.

before the potato crop, the rotted form is to be preferred but fresh manure has given good results. Potash, phosphoric acid and "complete" fertilizer have increased the yield considerably at different stations, but the cost of the fertilizer and its application often more than equals the value of the increase. It is probable that in truck gardening one or more of these may be used with profit, but only careful testing under the soil conditions that exist in different parts will determine this point. At Saskatoon the potato crop has responded better than most other crops to the use of both manure and commercial fertilizers.

334. The Choice of Varieties.—Several qualities combine to determine the suitability of different sorts for

our conditions. Among these, yield, cooking quality, disease resistance, early maturity, shape and depth of eyes, are among the most important. Many scores of potato varieties have been tested in Western Canada and the same ones have not proven best under all conditions. This is one crop the leading varieties of which can be easily, cheaply and satisfactorily tested out on any farm. And it is very desirable that this be done where the soil and climatic conditions are different from those existing at one's nearest experiment station.

At Brandon the early varieties recommended are: Bovee, Hamilton's Early and Early White Prize, while the main crop sorts are Empire State, Wee MacGregor and Rawlings Kidney.

At Saskatoon the leading early variety is Early Ohio; the best medium early ones are Irish Cobbler, Rochester Rose and Everett. Among the best late varieties are, Carman No. 1, Gold Coin, Table Talk and Wee MacGregor.

At Indian Head the white varieties recommended are: Carman No. 1, Empire State and Gold Coin. The pink sorts recommended are Everett and Vick's Extra Early.

At Rosthern, Dreer Standard, Morgan's Seedling and Everett have proven most productive, but the white varieties recommended are Irish Cobbler, Dalmeny Beauty and Carman No. 1 and the pink varieties Everett, Reeves Rose and Rochester Rose.

At Scott, Morgan's Seedling, Rawlings Kidney, Wee MacGregor, Table Talk and Gold Coin have yielded the most over a period of three years.

At Lethbridge the early varieties recommended are: Irish Cobbler, Vicks Extra Early, Rochester Rose, Reeves Rose; and the best maincrop varieties are Gold

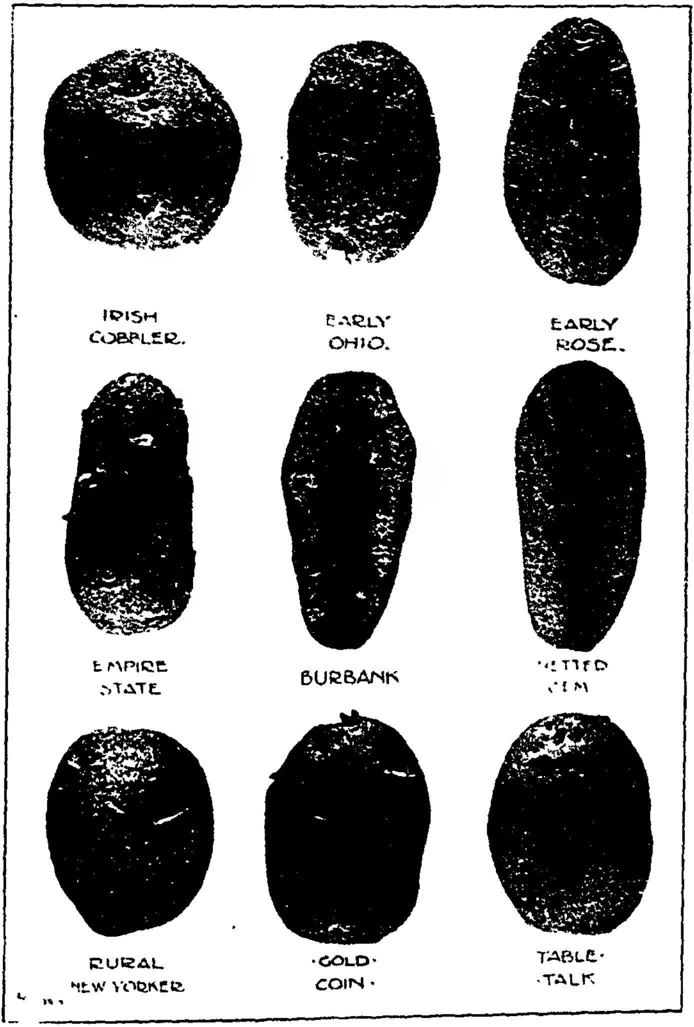

Fig. 123.—Representative Tubers of Different Groups of Potatoes.

Coin, Wee MacGregor, Table Talk, Empire State and Irish Cobbler.

At Lacombe the following early varieties have done well: Irish Cobbler, Houlton Rose, Early Norther. The maincrop sorts recommended are Table Talk, Empire State, Wee MacGregor and Epicure.

Fig. 124.—Table giving five years' average yields (1912-16 inclusive) of the six heaviest yielding varieties of potatoes at several different stations from "The Potato in Canada," by Macoun.

	Brandon	Indian Head	Saskat'n 1911-16	Scott	Rosth'n 1911-15 incl.	Lethbridge	Lacombe
	bu. lbs	bu. lbs.	bu. lbs.	bu. lbs.	bu. lbs.	bu. lbs.	bu. lbs
Irish Cobbler	.....	364 34	.....	.....	.....	341 39	...
Dalmeny Beauty ..	.....	.....	.....	.....	.....	352 11	.....
Table Talk	407 03	353 23	.....	304 02	.....	.....	424 10
Woodbury White Rose	405 03	.....	.....	.....	.....	.....	.....
Late Puritan	.....	.....	.....	.....	432 24	.....	.....
Houlton Rose	....	395 03	267 42	.....	.....	.....	.....
Early Norther	.....	.....	.....	.....	.....	.....	414 29
Reeves Rose	373 46	.....	.....	.....	.....	.....	.....
Valley Success	383 19	.....	.....	.....	.....	.....	.....
Everett	.....	....	267 41	.....	498 12	.....	....
Rochester Rose ...	.....	.....	.....	.....	.....	.....	.....
Early Ohio	.....	.....	293 47	.....	.....	.....	.....
Epicure	.....	.....	.....	.....	.....	.....	408 39
Morgan Seed'ing ..	..	.....	.....	337 52	.....	343 18	408 19
Vick's Extra Early	....	.....	....	.....	.....	.....	....
Money Maker	.....	.....	.....	.....	485 36	.....	....
Rawlings Kidney ..	373 43	.....	.....	317 51	479 36	.....	.....
Wee MacGregor ..	393 35	391 06	.....	317 16	.....	.....	402 49
Dreer Standard ...	.....	372 25	.....	.....	512 24	.....	....
Gold Coin	.....	413 04	.....	292 03	.....	361 02	.....
Carman No. 1	.....	.....	279 09	284 46	.....	.....	.....
Pingree	.....	.....	264 32	.....	.....	.....	.....
State of Maine ...	.....	.....	255 28	.....	.....	.....	.....
Empire State	.....	.....	.....	.....	.....	344 32	439 33
Factor	.....	.....	.....	.....	.....	334 29	.....

335. Classes of Potatoes.—The very large number of potato varieties now being grown in different parts of America induced Mr. Wm. Stuart of the Bureau of Plant Industry, United States Department of Agriculture to endeavor to reduce them to a small number of

classes or groups. The result of his work is given in U. S. D. A. Bulletin No. 176, entitled "Group Classification and Varietal Descriptions of some American Potatoes." He places all of the varieties in eleven groups. These groups, with brief descriptions and the commonly-grown varieties of each are as follows:

Group 1. **Cobbler**—roundish, creamy white; flowers, light purple sometimes almost white: **Early Petoskey, Extra Early Eureka, Irish Cobbler.**

Group 2. **Triumph**—roundish, creamy white with splashes of red, very early; flowers, very light purple: **Bermuda Early, Noroton Beauty, Quick Lunch (Uncle Gideon's), (Bliss) Triumph, Stray Beauty.**

Group 3. **Early Michigan**—oblong, somewhat flattened, white or creamy white, occasionally pink around bud-eye cluster in Early Albino; flowers, white; **Early Albino, Early Michigan, Early Puritan, Early White Prize, Woodbury White Rose.**

Group 4. **Rose**—slightly flattened, flesh colored or pink, except in White Rose; flowers, white in sections 1 and, rose lilac in section 3;
Section 1.—**Clark No. 1, Early Fortune, Early Norther, Early Rose, Early Sunrise, Early Thoroughbred, Everett, Extra Early Vermont, Houlton Rose, Late Rose, Northern Beauty, Rochester Rose.**
Section 2.—**Manistee.**
Section 3.—**Crine Lightning, Lee Favorite, New Ideal, New Scotch Rose, Seneca Beauty.**

Group 5. **Early Ohio**—round to oblong, flesh colored or light pink, with small, raised russet dots; flowers, white; **Early Ohio, Early Market, Early Six Weeks, White Ohio, Ohio Junior.**

Group 6. **Hebron**—elongated, somewhat flattened, creamy white clouded with flesh color or light pink; flowers, white; **Country Gentleman, Crown Jewel, Early Beauty of Hebron, Early Bovee, Gem of Aroostook, Harbinger, Late Beauty of Hebron, New Queen, Quick Crop, White Elephant, Morgan Seedling.**

Group 7. **Burbank**—long cylindrical to somewhat flattened, white to creamy white, deep russet in section 2; flowers, white.
Section 1. **Burbank or Burbank Seedling, Money Maker, White Beauty, White Chief.**
Section 2. **Californian Russett, Cambridge Russet, New Wonderful, Hammond Wonderful.**

Group 8. **Green Mountain**—oblong, usually broad, flattened, creamy or light russet color; flowers, white.
Section 1. **Carman No. 1, Clyde, Deleware, Dooley, Empire State, Freeman, Gold Coin, Green Mountain, Green Mountain Jr, Norcross, Snow, State of Maine, Uncle Sam.**
Section 2. **Charles Downing.**

Group 9 **Rural**—round flattened to oblong flattened; flowers, central portion deep violet, growing lighter towards the outer portion, five points of corolla white or nearly so;
Section 1. **Carman No. 3, Dooley** (as grown in Western Ontario), **Great Divide, Million Dollar, Noxall, Rural New Yorker No. 2 Sir Walter Raleigh, White Giant,**
Section 2. **Dibble Russet.**

Group 10. **Pearl**—round flattened to heart-shape flattened, usually heavily shouldered, skin dull white, dull russet, or brownish white in section 1, or a deep bluish purple in section 2; flowers, white.
Section 1. **Pearl.**
Section 2. **Blue Victor.**

Group 11. **Peachblow**—round, round flattened or round oblong, skin creamy white, splashed with crimson or solid pink; eyes usually bright carmine; flowers, purple; **Improved Peachblow, Peachblow, Nott Peachblow.**

336. The Improvement of Potatoes.—The potato is being improved, as in the past, by taking advantage of one of more of the different causes of variation, chief among which are natural crossing, artificial crossing and bud variations or sports.

When natural crossing is taken advantage of to secure new varieties the seed from the seed balls is used. This is usually planted in the hot house in the late winter or early spring and the small seedlings transplanted to the field in late May or early June. The tubers from each of these plants are generally different from each other and each hill may produce a new variety. The tubers are always small the first year. The progeny of each hill is kept separate and planted the following year. During the summer and at harvest time of the second year observations are made on the earliness and disease resistance of the plants and on the shape, size, color, depth of eyes and yield of each strain, the best only being retained for further trial. Many different types of potatoes may be secured in this way from the seeds of a single ball.

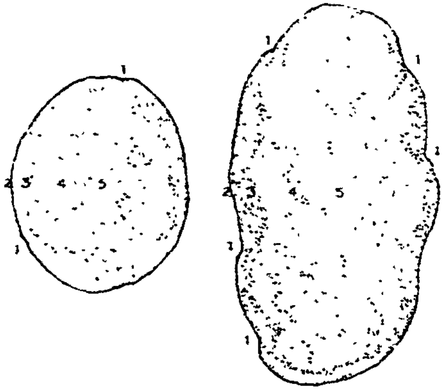

Fig. 125.—Transverse and Longitudinal Sections of Potato.

(1) eye; (2) skin; (3) cortical or cambium layer (4) external medullary layer; (5) internal medullary layer, pith or water core. A good potato has a wide cortical layer and a narrow or small internal medullary area; a poor potato has a narrow cortical layer and a comparatively large amount of pith.—(After Zavitz)

The advantage of artificial crossing over natural crossing in the improvement of the potato lies in the fact that the male parent as well as the female parent may be chosen by the breeder. The most desirable varieties may therefore be used as parent plants, with the greater pros-

pect of more promising strains from the offspring. "The crossing is done by removing the stamens from the flower before the pistil pushes through the bud, which is usually a day or two before the flower opens. All the flowers that are too far advanced and the buds which have not developed enough, should be removed before this operation. The emasculated flowers are then covered with a small paper bag, some of the stems being enclosed also. In another day or two these emasculated flowers are in condition to receive the pollen from the other plant. This is gathered by taking flowers containing it from the desired male parents. The pollen is then either shaken from the anthers on to a watch glass or, as is practised in the Department of Agriculture at Washington, jarred from the anthers on to the thumb nail after removing the pistil. The bags are then removed from the emasculated flowers, the pollen applied and the bags replaced, enclosing some foliage as before."*

When the seed balls are ripe they are gathered and mashed and the seeds washed out of the pulp. These seeds are planted in the spring in the same way as indicated in the preceding paragraph.

In nature certain variations in potatoes occur without apparent cause. These are spoken of as bud variations or sports. When these variations are favorable, advantage should be taken of them by man. This may be accomplished by selecting each year at the time of harvest the hills that produce the largest yield of the best tubers. One can not be assured that he is getting the best by an examination of the tubers selected but, if kept up from year to year, this practice is sure to result in the elimination of the least desirable and the increase of

* Adapted from "The Potato in Canada", by W. T. Macoun.

the most desirable strains in a mixed lot, or of the most favorable variants in a pure variety.

For best results the progeny of each selected hill should be kept separate and planted in rows of equal length and having the same number of hills. At harvest time the low yielding rows may be discarded and the high yielding ones retained. This is known as the hill selection or pure line or pedigree method of isolating pure strains. This work with potatoes can be much more easily and satisfactorily carried out than with any of our other commonly grown crops.

337. Importance of Source of Seed.—From whatever source seed is obtained care should be taken to see that it is free from disease. In addition to this, seed of strong vitality is much to be preferred. Vitality is evidenced by the firmness of the tuber itself as well as by other factors which are not apparent to the eye, namely, the climatic conditions where the seed was grown and the presence of certain diseases. Northern grown seed and seed grown in the cooler, more humid areas of the West is believed to produce more vigorous plants than seed of the same varieties grown in the southern and drier parts. In Great Britain and United States this principle is well appreciated and it is a common practice for southern growers to secure their seed from northern areas. This is a phase of potato production upon which little positive information for our particular conditions in the West is available and one that should be studied scientifically at the earliest opportunity.

It has often been pointed out that immature tubers are likely to produce more vigorous plants than well ripened ones. Whether this is due to immaturity alone seems not to have been well established, nevertheless it

has been commonly observed that seed potatoes grown in a cool, moist climate or in a cool, moist season, are more productive than those grown in a warm, dry climate or season.

338. Changing of Seed.—Under some conditions it is desirable to change the seed. In the case of certain physiological diseases of potatoes a change of seed is the only remedy. Generally speaking, however, this is a bad practice unless it has been found by experience that the tubers produced on ones own farm are either diseased or are not as productive as those of the same variety secured from another place. There is as yet no positive evidence to show what portions of Western Canada produce the most vigorous tubers for seed. In the absence of disease and until this information becomes available, growers would do well to use their own seed. There is some reason to expect that tubers produced in the cooler and more humid parts will be found to produce more vigorous plants than those grown in the warmer and drier parts.

339. Selection of Seed.—Our virgin soils are now quite free from disease and it should be the grower's firm determination to keep them so by rejecting all seed that contains any semblance of disease other than common scab. In addition to this, firm, unwilted potatoes that have not sprouted will produce the most vigorous plants.

340. Treatment of Seed.—Potatoes, like the seed of grain crops, should be "treated" to aid in controlling disease. Either a solution of formalin or corrosive sublimate will aid in the control of, but may not entirely prevent potato scab. One pound of formalin to 30 gallons of water is the proper strength, and the potatoes should

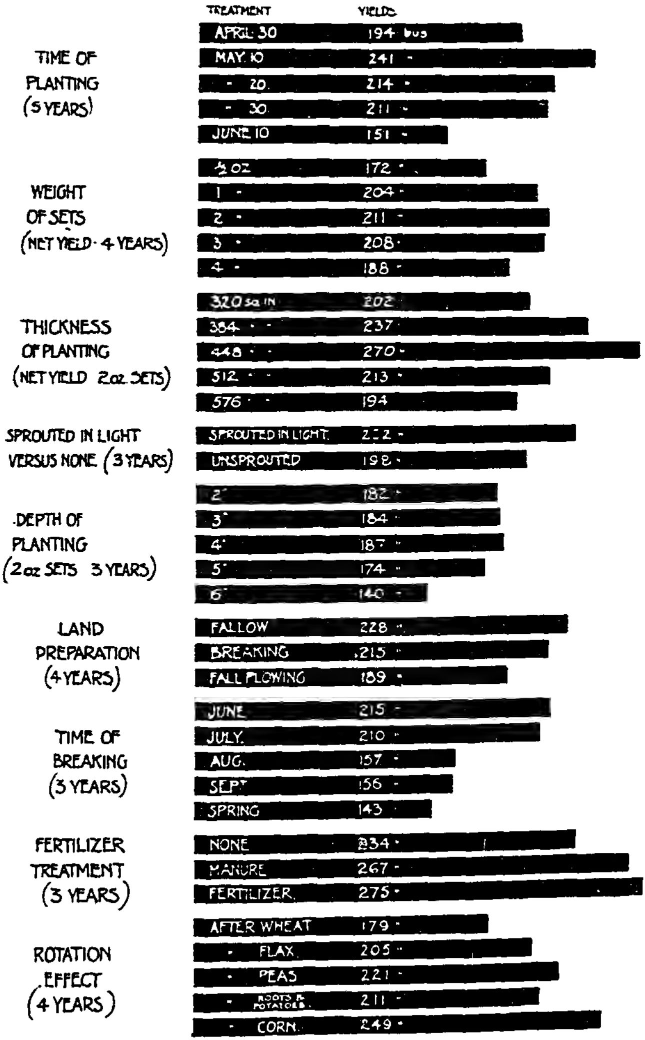

Fig. 126.—Culture of Potatoes—Summary of Tests at Saskatoon.

be soaked in this solution for 2 hours. If corrosive sublimate is to be used one ounce to 7 or 8 gallons of water is required. The tubers should be soaked in this for 2 hours. It should be remembered that corrosive sublimate is a deadly poison and in treating potatoes with it wooden retainers should be used because of its corrosive action on metal vessels.

341. Size and Condition of Sets.—The larger the set planted the larger the yield will be. But the net yield, that is, the total yield less the number of bushels of seed planted is greatest when sets about two ounces in size or rather smaller, having about two eyes in each set, are used. The size of the set should vary with the size of the potato and the number of eyes it contains. The fewer eyes in a tuber the larger the portion planted should be. Whether the seed end or the stem end of a large tuber is better depends upon whether the eyes in the stem end develop as well as those in the seed end. Both ends are equally good for seed if the eyes are not partially or wholly dormant in the stem end. The eyes in the seed end generally develop first and more of them are likely to grow. For these reasons the seed end often produces an earlier crop and a better stand. The seed ends are also likely to produce more small potatoes for the reason that more stalks develop from the greater number of sprouts.

Because of the fact that some of the sets cut from the middle and stem end of large tubers remain dormant and do not grow, thus lessening the stand, larger yields have been secured in some tests from the use of small uncut potatoes than from sets of equal size cut from large tubers. It has been pointed out, however, that this increase was due altogether to a better stand. The danger

of using small potatoes for seed lies in the fact that many of them may have come from diseased hills. Unless the crop is known to be free from disease the use of small potatoes for seed should be discouraged. The advantage of cheapness and saving of time in cutting are appreciable where small potatoes are used, but the risk of increasing disease by this practice is so great that as a rule it should not be followed.

If tubers are cut, they should be planted as soon as possible after cutting or in case some delay makes it impossible to plant at once they should be sprinkled with land plaster in order to prevent excessive drying. The yield decreases with the length of time the tubers are cut before planting. Land plaster dusted over the cut sets lessens the damage caused by delay in planting after cutting.

342. Time of Planting.—The stems and leaves of young potatoes will freeze with a very light frost. Planting should therefore be delayed until danger of heavy spring frosts is past. At Saskatoon in each of the years 1914, '15, '16 and '17 the largest yields were secured from plantings made during the first half of May. There is considerable danger of frosts even after this time but some risk in the spring must be run in order to have the crop fairly well developed before fall frosts come. For small areas of early potatoes earlier planting than this might be practised. It should, however, be remembered that the earlier the planting the greater the damage from late spring frosts. Rather later planting is a common practice among many good farmers. The last half of May is the usual planting time.

343. Depth of Planting.—The depth to plant varies with the type of the soil and its moisture condition.

Potatoes should seldom be planted less than two, nor more than five inches deep. Generally $3\frac{1}{2}$ to 4 inches is best. Where the crop is to be harrowed before the plants come up, deep planting is desirable but in gardens or in other places where harrowing is not practised at this time shallow planting will generally be found to give larger returns and will always give an earlier crop.

344. Distance Apart of Rows.—The drier the district and the less moisture the land contains the wider apart the rows should be. Under normal soil conditions on fallowed land rows 30 to 36 inches apart are generally used. On fall or spring plowing rows 36 to as wide as 48 inches may be used. The cheaper the land and the more expensive the seed, the wider the rows should be. In kitchen gardens where hand tillage only is given, hills 18 to 24 inches apart each way give best results.

345. Distance Between Sets in Rows.—This varies with the width of the rows. The wider the rows the closer the sets should be. Under normal conditions sets are placed from 12 to 18 inches apart.

346. Amount of Seed to Plant.—The amount of seed planted varies widely. In Europe 35 bushels or more is frequently used while in parts of the United States as little as 10 bushels is sometimes planted. Obviously the amount used depends upon three factors, (1) the distance apart of the rows, (2) the distance apart of the sets within the row and (3) the weight of the sets. The number of active eyes per tuber is also a determining factor, some varieties having more than others. From 12 to 30 bushels, depending upon the climatic conditions, is generally used in the West. The following table indicates the amount of seed necessary when planted with sets of different size at different distances apart:

Weight of seed piece	Hills 36″ x 9″ apart. or 27″ x 12″ " or 18″ x 18″ "	Hills 36″ x 16″ apart or 48″ x 12″ " or 24″ x 24″ "
1 oz.	20 bus.	11 bus
1½ "	30 "	17 "
2 "	40 "	22 "
3 "	60 "	34 "
4 "	81 "	45 "

347. Method of Planting.—Potatoes may be planted by hand or with a machine planter or they may be plowed in. The hand method is, of course, the most expensive and is suitable only for small areas such as the kitchen garden. Where potatoes are grown in a commercial way they should be either plowed in or the potato planter used. A potato planter is expensive but where a considerable area is grown each year it is a profitable investment.

When potatoes are plowed in it is generally best, after planting one row, to cover same by plowing the next furrow as in ordinary plowing. The general plan is to plant in every third furrow. When putting in potatoes with the plow a common practice of many growers is to plow six or eight inches deep and instead of placing the sets in the bottom of the furrow stick them into the mellow soil on the side of the overturned furrow at a point about four inches from the top of the soil. This plan takes more time in planting but results in better shaped and more uniform tubers and in less injury and displacement from the horses feet.

After planting, the soil about the potatoes should be firmed down either with the foot or hoe or the packer or planker, care being taken to see that on heavy soils or those that bake the soil is not made too firm in which case less satisfactory development and more misshapen tubers will result.

348. A Home-made Planter.—A simple home-made planter may be made by attaching a hopper, having an opening in the front side at the bottom, to the stem of the seat of a two furrow gang plow. The operator sits with his back to the horses and drops the potatoes into

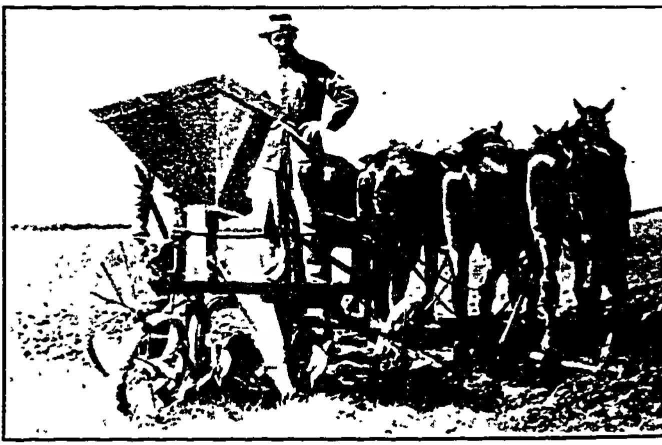

Fig 127.—A Home-made Potato Planter

a zinc or tin conveyor which carries them to the bottom of the furrow made by the first plow where they are covered, immediately by the second plow. A definite number of sets is planted in the distance covered during each revolution of the plow wheel, thus insuring uniformity in thickness of planting. If it is desired to plant the potatoes four feet apart, no seed is dropped the second round. If three foot rows are wanted a single furrow plow should follow or precede the home made planter.

At a cost of a few cents for material and two or three

hours time a very serviceable planter can thus be made from a two-furrow gang plow.

349. Cultivation after Planting.—After the potatoes are planted the land should be harrowed at intervals to prevent the growth of small weeds. After the plants are up the patch can often be kept clean without any hand work if harrowed crosswise of the rows; when they reach a height of four or five inches intertillage should commence and it should continue throughout the season, the objects being, to control weeds, and to lessen the evaporation of moisture by the formation of a soil mulch.

The practice of hilling potatoes does not appear to be as desirable here as in humid climates. Medium hills are necessary to prevent sunburn and to lessen the danger to the tubers from early fall frosts. Low hills rather than high ones have usually been found best under dry conditions on most soils. High hills result in better drainage of low lying soils, in easier digging, and a slightly earlier crop, but generally in a decreased yield under normal soil conditions in this climate.

350. Insects and Diseases.—Fortunately but few insects attack the potato crop in the newly settled areas of the West. The potato beetle, or potato bug, is found occasionally in some of the older settled districts. The life history and means of controlling it are discussed in sec. 400. The common diseases of potatoes grown under western conditions are discussed in considerable detail in Chapter XV.

351. Harvesting.—Three methods of harvesting, depending upon the size of the area in crop, are commonly followed. The oldest and most suitable for small cramped areas, such as the kitchen garden, is digging by hand.

In modern days when labor is costly this method is not advisable for larger areas. The second method is to turn the tubers out with a plow. This is quick and cheap but very wasteful of potatoes and also of the picker's time. Many of the tubers remain covered or partially so and

Fig. 128.—Harvesting Potatoes With a Modern Digger.

the wastage in digging is high. The third and best method of harvesting is with a potato digger. Many forms of this machine are on the market. The cheapest is a modification of the double furrow plow, having a flat point instead of a share and in place of the ordinary mold board it has three or four tines on each side and a shaker attachment below. The most expensive but most efficient diggers elevate the potatoes and soil, shake the tubers from the dirt, separate the tops from the potatoes and leave the latter in a neat row or in boxes or heaps as may be desired. Where large areas are grown the more expensive potato digger is a good investment. This necessitates, of course, more capital. Such a digger re-

quires four horses to operate, but will dig from three to five acres or more a day.

Potatoes should be dug before the fall frosts are severe enough to damage any of the tubers in the ground. Fine dry weather should be chosen for this operation, and the potatoes should be dry when stored. Digging in the forenoon and picking up in the afternoon permits them to become dry. If stored when damp, disease and decay are much more likely to develop.

Digging is usually done in late September or some time after the plants have ripened naturally or the tops have been frozen. If the crop is diseased late digging is preferable, as the decayed tubers can be eliminated when picking thus lessening the chances of the sound ones becoming affected during storage. The potatoes should all be safely pitted not later than the end of the first week in October, otherwise in occasional seasons serious losses from frost may be experienced.

352. Storing.—Potatoes in storage should be kept at a temperature of 32 to 40 degrees F. in an atmosphere of normal humidity, neither too dry nor too damp and the room should be kept dark. A cellar or pit that will keep the potatoes at as low a temperature as possible without freezing will be found to result in satisfactory storage conditions. In large bins spaces underneath and around the sides should be arranged, and open slatted columns placed in the centre of each to provide for the circulation of air. A high temperature should be avoided for the reason that it causes evaporation from the potatoes, thus lowering the vitality and market condition of the tubers for seed or food and at the same time increasing the shrinkage as well as the spread of any diseases that may be present. (See sec. 326).

353. Marketing.—Western farmers have not always supplied even our own home market with potatoes. There have been no efficient means developed to encourage or facilitate either the marketing or the quick, easy, cheap and safe handling of the crop between the field and the city home or the produce merchant's storehouse. As a result of this condition the markets are relatively inaccessible, the cost of marketing is high and in years of large production the price is low. The producer thus becomes discouraged and grows a smaller acreage which in times of shortage produces too little to supply our own needs.

The fact that every spring consumers pay very high prices for potatoes is in itself convincing evidence that storage facilities either on the farm, at the railway siding or in the town or city should be provided, and that closer relations should be established between the grower and the produce merchant. At present it is often easier for the merchant to buy a carload of potatoes in the east, and sometimes cheaper, than it is to buy one in the central West. The producer, by co-operative effort, must make it as easy for the merchant in the cities to buy his potatoes in the West as he can now in times of scarcity buy them elsewhere. Otherwise our city market may not be supplied with home grown tubers. Unless we can co-operate to secure our local markets there would seem to be little use at present to get outside ones. It seems apparent that only by co-operation in shipping and marketing will this condition be corrected.

The Co-operative Organizations Branch of the different local governments are only too glad to aid local growers in an attempt to get and keep our local town and city markets for home grown products.

354. Growing Early Potatoes. The following practices have been found to result in increasing the earliness of the potato crop. They will be of interest to the consumer who pays the high price for new potatoes as well as to the producer who receives it.

(1) The use of an early variety.—Early Andes, Early Triumph, Six Weeks, Early Ohio and Irish Cobbler are some of the early sorts. Irish Cobbler is a little later

Fig. 129.—Potatoes Growing in the Far North.
The above scene was photographed within 14 miles of the Arctic Circle at Fort Good Hope, MacKenzie River. Courtesy, Department of the Interior.

than the others, and both the Cobbler and Early Ohio are more productive than the others named.

(2) Sprouting the seed tubers in the light.—If the seed potatoes are placed in shallow trays in the sunlight in a room that is cool at first and warmer later and left from two to three weeks before planting, a few vigorous green sprouts will develop. If these potatoes are then planted carefully so as not to break off the sprouts they will be found to result in a heavier as well as an earlier crop.

(3) Using large sets.—large sets, whether whole or cut, usually produce an earlier crop than small ones. The disadvantage in using large sets is in the added cost of the extra weight of seed used.

(4) Shallow planting.—this results in a quicker growth and earlier maturity than deep planting.

(5) Planting on warm soils.—well drained sandy loams, produce earlier crops than heavier types of soil.

(6) Any practice that results in bringing the potatoes above ground early in the spring results also in exposing them to greater danger from frost. It is difficult to lessen this risk but it has been found that a thin loose covering of soil thrown over the small plants with an outthrow cultivator, or with the hoe or rake, will protect them from quite severe frosts. This is not practicable on a large acreage but may be done on small areas in times when the temperature promises a big drop. Strawy manure may be used in the same way.

355. Potato Grades.—The regulations concerning the sale of potatoes by grade, as defined in the "Inspection and Sale Act" as amended in 1918 are as follows:

"No person shall sell or offer for sale any potatoes represented to be of,—

(a) Number 1 quality unless such potatoes consist of specimens which are sound, of similar varietal characteristics, which are practically free from dirt or other foreign matter, frost injury, sunburn, second growth, cuts, scab, blight, dry rot and damage caused by disease, insects, or mechanical means. The minimum diameter of potatoes of the round varieties shall be one and seven-eighths inches, and of potatoes of long varieties one and three-fourths inches. In order to allow for variations incident to commercial grading and handling, five per

centum by weight of any lot may be under the prescribed size and, in addition, three per centum by weight of any such lot may be below the remaining requirements of this grade.

(b) Number 2 quality unless such potatoes consist of specimens which are sound and practically free from dirt or other foreign matter, frost injury, sunburn, second growth, cuts, scab, blight, dry rot, and damage caused by disease, insects, or mechanical means. The minimum diameter of potatoes of the round varieties shall be one and seven eighths inches, and of potatoes of the long varieties one and three-fourths inches. In order to allow for variations incident to commercial grading and handling five per centum by weight of any lot may be under the prescribed size and, in addition, three per centum by weight of any such lot may be below the remaining requirements of this grade.

This section shall not apply to seed potatoes.

"Practically free" means that the appearance shall not be injured to any extent readily apparent upon casual examination, and that any damage from the causes aforesaid can be removed by the ordinary processes of paring without appreciable increase in waste over that which would occur if the potato were perfect. Loss of the outer skin (epidermis) only shall not be considered as an injury to the appearance.

"Diameter" means the greatest dimension at right angles to the longitudinal axis."

CHAPTER XIII

CORN

A Dry Farm Fodder for the Warmer Parts.

Within recent years corn or maize, "The Giant Grass" of warmer climates, has demonstrated conclusively that it has a useful place in the agriculture of northern regions. It does not, of course, reach its highest perfection here; nevertheless, it may be grown with considerable advantage on many farms where, for any reason, the supply or variety of fodder is likely to be limited. Under favorable conditions it gives good yields, is an excellent preparation for cereals, aids in the control of weeds and soil drifting and lessens the cost of grain growing.

356. Good Yields of Fodder.—Corn under favorable conditions produces large returns. In the least favorable season during the past five years at Saskatoon corn produced 7 tons green weight per acre, while in the best years it yielded over 20 tons per acre. At Indian Head the average yield for some of the leading varieties for a period of five years is over 17 tons green weight per acre. Equally good yields have been secured in southern Alberta, and heavier ones in the Red River Valley of Manitoba.

357. High Yields after Corn.—The yield of small grains when sown on corn ground that has been well cultivated

with the disc and harrows is generally greater than after any other crop. Cereals sown on corn ground following a fallow, approach and sometimes exceed the yield of the same crop when sown on fallowed land. The crop

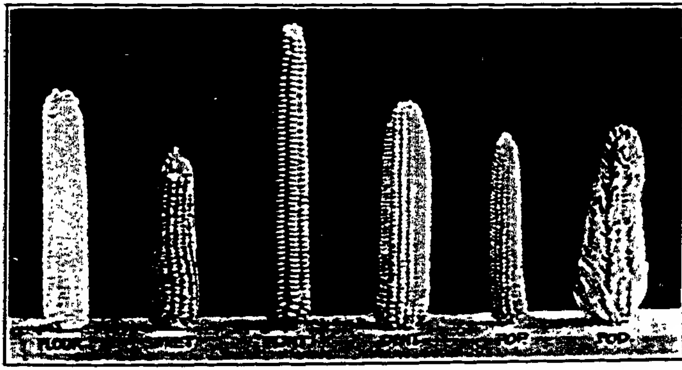

Fig. 130.—Ears of Different Species of Corn.

on corn ground also matures earlier than that sown on fallowed ground. A similar experience, both in respect to yield and earliness, has been reported by the North Dakota and Montana Experiment Stations, the Brandon, Indian Head and Lethbridge Experimental Farms and by many farmers as well.

358. Intertillage Aids in Weed Control.—The intertillage necessary for the successful production of corn aids materially in the control of weeds which are at present the most serious hindrance to profitable grain farming in the older parts of the West. What is true of the older settled areas to-day will be true of the newer districts in the very near future. The corn crop offers another means of coping with the weed problem.

359. Corn Stubble Lessens Soil Drifting.—Soil drifting is becoming a real menace to profitable crop production

on our heavy as well as on our light types of soil. Its worst effects are to be observed on fallowed land, either the year of the fallow or the spring succeeding. In many cases where the frequent use of the fallow is not necessary, corn, if introduced occasionally, will perform, in a large degree, the function of the fallow, and the corn stubble, while not preventing, will considerably lessen the drifting. And what is of greater moment, the manure resulting from the feeding of the corn crop will aid in replacing the organic matter which is so essential to the control of both soil drifting and soil moisture.

The cost of producing farm crops must be kept down if farming as a business is to be profitable. Corn ground that has been well intertilled and kept clean does not need to be plowed, hence the cost of preparing it for a cereal crop is very considerably reduced, and to that extent the profit on the succeeding crop is increased. If the corn crop is not kept free from weeds, the favorable yields reported cannot be expected from surface cultivation of the land. Neither will its effect on weed control be what the pioneer corn grower may expect. Corn presents an opportunity for weed control, and for lessening the acreage in fallow, but unless the land is kept clean these advantages may be largely lost.

360. Uses of the Corn Crop.—In Western Canada field corn may be grown either for fodder, for soiling purposes for "hogging off", or for silage. As yet it is grown very little for grain. The form in which it is generally used at the present time is as cured fodder for cattle. For soiling purposes, however, many dairy farmers find it to be unexcelled for milk production in the dry part of the summer when the pastures have dried up. The "hogging off" of early maturing corn in the warmer parts of the

West, while not yet practised to any extent, promises to aid materially in cheapening the cost of producing hogs as well as in lowering the cost of crop production.

Corn is the most suitable silage crop we have. It is, however, doubtful whether at this time it will pay the

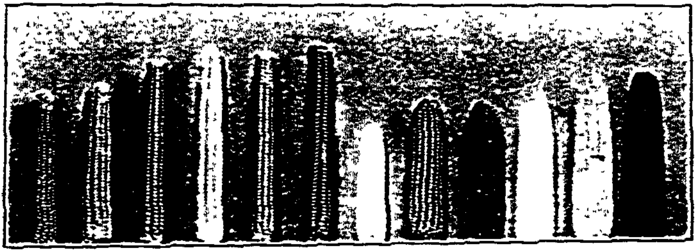

Fig. 131.—Types of Flint and Dent Corn Varieties.

On the left, six varieties of "flint" corn; on the right, six varieties of "dent" corn, as grown in the corn belt. From left to right, Flint: Mercer's, Compton's Early, Longfellow, North Dakota, Triumph and King Philip. Dent: Minnesota No. 23, Northwestern, Minnesota No. 13, Wisconsin No. 7, Reid's Yellow and Red Dent.

average man to erect a silo, although there is little doubt about the desirability of dairymen and other owners of large herds of cattle doing so. In this connection it should be pointed out that a cheaper form of silo, and one that in the western States is now being used quite extensively, namely, the "pit" silo, is likely to fill the early need of the small stockman quite satisfactorily.

The early varieties of corn have ripened in the southern parts of all three Prairie Provinces. A few men have seldom failed to get seed sufficiently matured to grow. In southern Manitoba very good yields of grain have been secured in recent favorable seasons. As a grain crop, however much the future holds for us, at present it is not a commercial success except in local areas in the south and in favorable seasons elsewhere.

361. Suitable Soils.—Corn prefers a warm soil. Other conditions being similar it will start earlier and grow faster on a rich loam soil than on any heavier type. In our climate it has also been commonly observed that, except in years of early fall frosts, corn produces a much heavier growth of forage when planted on low-lying soil that is well supplied with moisture. A light, warm soil under similar conditions would no doubt yield more. The crop needs both a warm and a moist soil. When grain is desired warm soils are essential, but where forage only is looked for, while warm soils are favored, the crop will do well on all except the coldest types.

362. Place in the Rotation.—On warm soils corn planted on fallowed land returns larger yields of fodder than that sown on either fall or spring plowing. On medium and heavy types which are colder both fall and spring plowing generally give better returns than fallow. If the crop is planted on fall or spring plowing, it will in some places take the place of the fallow. It is possible that this crop, if thoroughly intertilled and all weed growth controlled, may lessen very materially the necessity of such frequent fallowing as is now being practised by men in the dry belt. In Western North and South Dakota and Montana it is gradually taking the place of the fallow, while in parts of southern Manitoba it might well replace the fallow, even under present economic conditions.

The crop will do best on well prepared sod land, but if used for a substitute for fallow or to give opportunity for killing annual weeds it should follow one grain crop and precede another.

363. Soil Preparation.—If the land is grassy, fall plowing is preferable; if clean, thorough surface cultiva-

tion in the fall, followed by spring plowing well worked down immediately after the operation, is likely to prove satisfactory in the average season. If planted on fall or spring plowing the land should be well firmed down and the surface thoroughly cultivated. Farm yard manure gives more favorable results with corn than with most

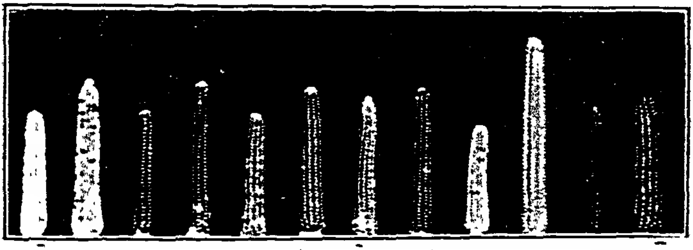

Fig. 132.—Western Grown Corn Compared with Eastern and Southern Grown.

Six pairs of ears from different varieties. The left one of each pair was western grown, the right, eastern or southern grown. From left to right in pairs, Squaw, Free Press, Gehu, Quebec Yellow, N. D. White, and N. W. Dent.

other crops. In the dry belt strawy manure should not be plowed under the year the corn is planted unless the land is to be thoroughly compacted afterwards. Thorough preparation of the surface is more essential for the corn crop than for any other cereal.

If the corn is planted on sod land similar cultivation to that given for wheat is all that is necessary. It will do well on breaking done later than is advisable for wheat. If fallow is used, the soil need not be as firm as for wheat. Fallowed land that has been manured before plowing is probably the best although the most costly preparation.

364. The Choice of Varieties.—The "Squaw" group contains the earliest and shortest growing varieties, and those that yield the least forage. The Improved Squaw and

the "Quebec" group are somewhat later but yield more forage and, where they mature, more grain also. The standard Dents and Flints of the corn belt seldom ripen a profitable crop of grain here but often out-yield all others in forage. To the Squaw group belong such varieties as Squaw, Old Squaw, Early Squaw, Stony Squaw, North Western Squaw, Assiniboia, Fort Totten, Burleigh County Mixed and Mandan. The best known of the Improved Squaw group are Gehu and North Dakota White, while the most noted of the Quebec group are the Free Press or Patterson and Quebec No. 28. The leading varieties of the later sorts are North Western Dent and Longfellow Flint. These with North Dakota White are at present generally preferred for forage. The Squaw, improved Squaw and Quebec groups promise most for grain or for hogging off.

365. Testing the Seed.—The percentage and vigor of germination of the seed should be determined before planting. This information, which for corn is more important than for any other crop, can be obtained easily and quickly by either the blotting paper or the soil method of testing. Seed that does not give a high germination test should either be discarded or a larger quantity of seed used.

In this connection it should be pointed out that in all corn growing regions the practice of buying the seed on the ear is followed almost exclusively. On those farms where corn is likely to be used in a large way and planted in hills it woud seem advisable to purchase the seed on the ear if possible. Ear corn sold for seed has generally received more or less selection. Such seed is likely to be higher in price, but the percentage and vigor of germination invariably more than offset the additional cost.

366. Planting the Crop.—Young corn plants are very susceptible to frost, hence the crop is commonly not sown until after the third week in May. From our observations it would seem that in the absence of late spring frosts, rather earlier seeding is desirable. In the year 1914 corn planted on May 10th produced more forage than any planted later. In 1915 when a severe frost came in June the May 30th seeding was best. The largest average yield during a four year test was from the May 30th seeding. The usual practice is to sow during the last week of May or the first week of June, the last ten days of May being generally recommended.

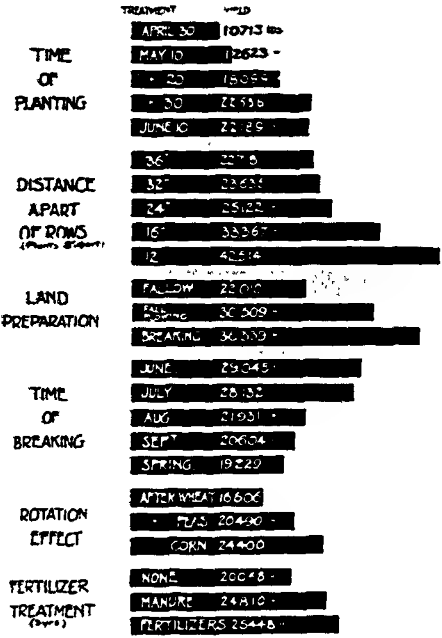

Fig. 133.—The Culture of Corn. Summary of tests at Saskatoon.

The two commonly used ways of planting corn are the check row, or hill method, and the drill method. As a general rule in this country rather more forage is secured from the drill method. On the other hand, the hill plan requires only about half the quantity of seed and gives opportunity for tillage in two directions—both lengthwise and across the rows. On clean land when forage

only is desired the use of the ordinary grain drill with four or five of the seed spouts closed and the fifth or sixth left open is a simple and expeditious method of putting in the seed and one that is quite satisfactory.

If grain is the object sought the hill method should be used; and, of course, this method should be followed on all land that is dirty and that will consequently benefit from the thorough tillage this plan permits.

When corn is planted in hills from 10 to 16 pounds, varying with the size of the seed and the distance apart

Fig. 134.—Cultivating Corn with a Two Horse Cultivator.

of the hills, is required per acre. When drilled in rows 3 feet apart about twice this quantity is necessary. When small seed, like that of "Squaw" corn is used much less is necessary to sow an acre than when the larger seeded sorts are grown.

367. Cultivation.—After corn is planted and until the crop is 6 inches high it may be harrowed with a light

harrow without doing serious damage to the crop. This practice is necessary in order to kill the thousands of small weeds that on most soils are sure to spring up. Harrowing once or twice before the corn is 6 inches high should be looked upon as a necessary operation. After the crop is high enough that the rows are clearly distinguishable intertillage should commence. The more cultivation the crop is given up to the time that it is impossible to get the horse or horses through between the rows, the heavier the crop is likely to be and the better condition the land will be in for the following crop.

If small areas only are planted to corn the one-horse cultivator is quite satisfactory. If, however, large areas are planted to this crop a two-horse two-row machine will quickly pay for itself in the saving of one man's time.

368. Time to Harvest.—The time to harvest the crop should be determined, first, by the maturity of the crop, and, second, by the probability of fall frosts. As a rule, in this country the crop should be left as long as possible and yet avoid frosts. We have in the past usually cut our corn in the first ten days of September. Occasionally frosts occur before this date, but sometimes they do not come until considerably later. A slight frost usually stops the development of the crop, without seriously lowering its feeding value. As a matter of fact, when corn is very green and immature a slight frost results in drying it out to some extent, and thus makes the fodder easier to cure. It also makes green immature corn less moist and the silage from it less sour. Of course a frosted crop that is to be ensiled should not be let dry out too much or it will not keep well in the silo. A heavy frost results in greater wastage in harvesting, and in a slight lowering of the feeding value of the crop.

By some men corn is left standing uncut until the pressure of fall work is past and the dried stalks are then cut and stooked. In cases where the short, early maturing varieties are grown for grain this practice would

Fig. 135.—Reducing the Labor of Harvesting Corn.
Cutting corn with a corn harvester at the Manitoba Agricultural College. By courtesy, Professor T. J. Harrison.

seem to have some advantages, since it gives opportunity for the more or less immature ears to harden the grain they carry, and thus aids in making it more fit for binning. On the other hand, the feeding value of the stalks is much decreased, and as these at the present time, under most western conditions at least, are generally of greater value than the grain they may carry, the arguments in favor of this plan lose much of their force.

369. Cutting.—The cutting may be done with the sickle, the binder, or the corn harvester. The first is the most laborious, and is advisable only when the crop is grown in a small way. The second plan is quite satisfactory in seasons when the corn is short, but is rather

hard on the binder. When corn is grown in large areas, and particularly when the crop is heavy, a corn harvester should be used.

A possible development for corn lies in its use as a pasture crop for cattle in fall or early winter. The economic aspects of this practice have not been studied but some men have reported favorably upon it. The difficulty and cost of the harvesting which comes at a very busy time would be lessened, but whether the net return would be worth the effort has yet to be determined.

370. Curing.—Depending upon the uses to which it is to be put, the corn crop is cured in different ways. Of course that used for soiling purposes is cut green and fed in that condition. If it is to be used for rough fodder for stock it is cured by stooking in the field or in long stooks near the buildings. The crop may also be preserved by means of a silo, which saves it in as nearly the natural condition as possible. There are many types of silo, but all of the "above-ground" types are rather expensive and at the present time can only be recommended for those having a considerable number of growing or fattening cattle or a dairy farm. The "pit" or "underground silo" is much less expensive, and, although less convenient, it promises to lend itself better to the conditions that exist on many western farms than does the more expensive "above ground" type, which large herd owners may find best.

371. Stooking.—In discussing the curing of corn in stooks and the preserving of it in the silo under Manitoba conditions Mr. W. C. McKillican, Superintendent of the Brandon Experimental Farm states:*

* In Dominion Experimental Farm's Bulletin No. 14 on 'Corn Growing in Manitoba''.

"There are two distinct methods of curing and storing fodder corn. The one almost universally practiced in Manitoba is to dry it in stooks. This system has the merit of being inexpensive, and is the best for a man who cannot afford to build a silo and buy or hire silo-filling machinery.

"In stooking corn, a home-made contrivance called a stooking-jack is a great help. It is made by putting two legs about four feet long on one end of a 16-foot scantling. Two or more holes

Fig. 136.—Corn in Stook at Lethbridge Experimental Farm.
By courtesy, W. H. Fairfield.

are bored horizontally through the scantling at from three to six feet back from the end that has no legs. An old broom handle is fitted loosely through one of these holes. The stook of corn is built by standing the sheaves around the junction of the broom handle and the scantling. When the stook is completed, the jack is removed by taking out the broom handle and then pulling away the scantling by the end that has the legs on; the other end slips loosely through the stook. If this implement is used and the stooks made large and straight they will stand up all winter. A good size of stook is one that is about six feet across on the ground and about three feet across at the band. All stooks should be tightly tied with a band of binder twine about three-quarters of the way up.

"About as satisfactory a method of handling stooked corn as any is to leave it standing in the stook until it is needed, and then draw it into the stable either by the sleighload or by dragging each stook with a chain.

"If it is desired to have the corn stored nearer the buildings, it may be piled against trestles in long rows. These rows should run east and west so that the snow will be carried through by the prevailing winds and not piled up in banks against the corn.

"Fodder corn cannot be stored by piling it up in mows or stacks unless it is put in layers with about four times its bulk of dry straw. If piled by itself it will heat and mould. The method of stacking it with straw has been tried at the Experimental Farm with satisfactory results. The corn kept well and the straw came out so flavored by the corn that the cattle ate it greedily; but it takes much extra work to stack it this way.

"Fodder may be stood up against a wall of partition or on top of a mow in a barn, and will keep in this way if it is dry when brought in and is not in too great bulk.

372. Storing in the Silo.—"The ideal way of storing fodder corn is in a silo. It is very much to be perferred to stooking."

"While silos are as yet quite few in number in Manitoba, they are increasing, and with the spread of mixed farming they are sure to become more common. No up-to-date dairy farm is complete without a silo, and for other types of animal husbandry a silo is almost as needful.

"The round silo is much to be preferred to the four-sided one. The corners of the latter cause uneven settling and are more subject to mould and freezing. A great many of the first silos made were of the latter type and were made by boarding up a corner of a mow in a barn. They are largely being replaced by cylindrical silos of cement or wooden stave construction. The two latter are the best types of silo. The cement silo has the advantage of solidity and durability. There is no danger of it being blown over by summer winds, and if well made it will last several lifetimes. The wooden stave silo has the advantage of cheapness and of being less subject to freezing than is the cement. We believe it is the more desirable silo for use in Manitoba, where low winter temperatures make the freezing of the ensilage a consideration that lessens the desirability of cement. With a stave silo, there is very little of this difficulty if the ensilage is taken out uniformly and not too slowly. A stave silo, if made of good material, will last fifteen or twenty years, so that lack of durability is not at all a serious objection to it.

"The nearer to full development that corn can be brought, the better grade of ensilage it will make. With the best efforts that can be made in Manitoba both in selecting varieties and in cultivating for the hastening of maturity, corn for the silo is likely to be rather on the green side. The quality of the ensilage made from this corn can be considerably improved if the corn is allowed to lie on the ground for about five days or a

week after it is cut by the binder before it is cut up and stored in the silo. This dries out a little of the moisture and brings on a maturing process in the stalks that makes an ensilage of less acidity than is obtained from green corn taken directly to the silo.

"One of the principal difficulties in the way of the greater adoption of silos is the cost of silo-filling equipment. It is necessary to have a machine to cut up the corn and elevate it to the top of the silo and power to drive such a machine. There are two types of cutting box in use, and it will depend on the power available which is the better to use. The cutting box with endless chain elevator is the cheaper kind and can be run with a two-horse tread power or a small gasoline engine. It works much more slowly than a blower and therefore can be kept going with fewer men and horses. This kind of cutting box is best for a man who is farming in a small way and has no powerful engine. The blower type of cutting box is much faster and more satisfactory where there is work enough to justify it. It requires a large engine (15 h. p. or more) to drive it, and a good strong force of teams drawing in corn to keep it busy. Wherever a farmer has an engine for plowing or threshing it will pay him to get a blower on account of the saving of time it permits. When silos become more common it will be possible for threshing machine owners to run a silo-filling outfit as well. It would prevent much lost time, as silo-filling can be done when it is too wet to thresh from stooks.

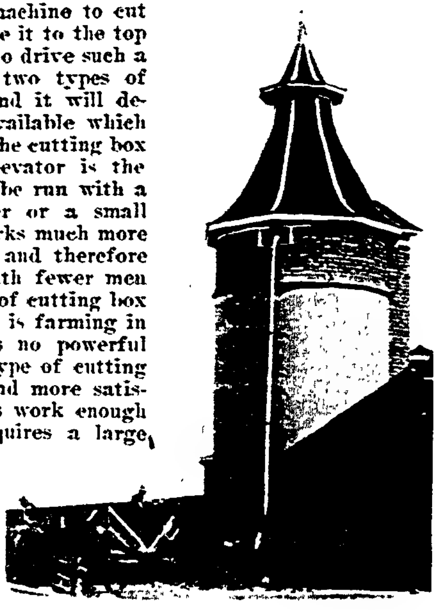

Fig. 137.—Filling Silo With Corn and Sunflowers.
Photographed at University of Saskatchewan, Saskatoon.

"The corn should be well mixed as it falls in the silo. The draft from the blower carries the heavy stalks to one corner and the leaves to another. The leaves will mould if left by themselves and should be mixed among the heavy parts. There is not much advantage in tramping the bulk of the corn in a silo. So

great a weight comes on it that the tramping makes little difference. It is better, however, to tramp around the edge as the friction of the sides of the silo hinders settling and tramping helps to make the settling more uniform. It is also advisable to tramp the last few feet at the top. A silo cannot be filled completely all at once. To get the greatest quantity in, it should be filled once, then allowed to settle for a few days, then filled again, and even the third or fourth time there will be room for a lot more. Different coverings for the ensilage are recommended, such as wet cut straw, etc. Anything that is solid and airtight is satisfactory. There is nothing better or more convenient than the corn itself. If the top is tramped and left alone, about six inches will rot and provide an airtight protection for the balance." (See Sec's. 297 to 301 and 218).

373. Equipment Necessary.—When corn is grown for fodder only, no equipment other than the hand planter and the one or two-horse cultivator should be secured at first. If after the crop has been tested thoroughly it is found to be satisfactory a horse-drawn two-row planting machine, or a two-horse cultivator, or a corn harvester, or all three may be purchased. Until the value of the crop to the particular type of farm management followed has been determined or carefully estimated these capital expenditures should not be made.

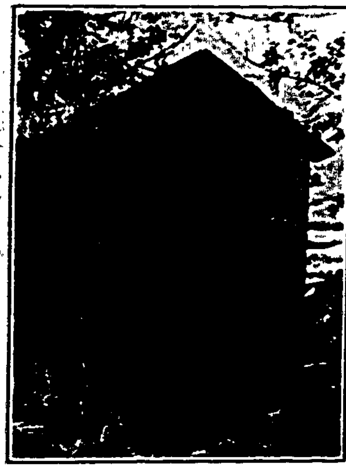

Fig. 138.—"Crib" for Storing Ears of Corn.
This corn crib was built in the early days by Mr. Stewart, of Maple Creek, and filled with ripe corn for several seasons before oats established itself as a cheaper concentrate for horses and other stock.

At first the grain drill or the hand planter may be used to plant the seed, the one-horse cultivator to till the crop

and the binder or the sickle to harvest it. The other machinery, including a cutting box, can be purchased from any of the leading implement houses as soon as they are needed.

374. Summary.—Corn is a warm climate crop, one that grows slowly in cool seasons, and one that suffers from even slight frosts. It produces large yields of fodder and but little grain in this climate. It is useful here for winter fodder, for soiling dairy cattle, for ensiling, for "hogging off", and possibly for pasturing. It is useful also because of its favorable effect upon the soil, the opportunity it affords to control weeds, soil moisture and soil drifting, and to lessen the cost of producing cereals. It prefers warm, moist, fertile soils in a good state of tilth. The short early native or improved native sorts, such as Squaw, Free Press and Gehu are best for general use for grain although Quebec No. 28 has done exceptionally well in southern Manitoba. The taller growing flints, such as Longfellow and North Dakota White, and the early dents, like North Western, are best for fodder. The seed should be tested before planting. The crop should be sown or planted as conditions determine. Planting should be done after danger of heavy frosts is over or between the 20th of May and the 10th of June, using 10 to 30 pounds per acre. Harrowing after the plants are up and regular and thorough intertillage are essential. Harvesting may be done by hand, with the binder or with the corn harvester. The crop may be fed green, pastured off, cured as dry fodder or preserved as ensilage. No costly equipment is necessary to start growing it.

CHAPTER XIV.

THE COMMON INSECT PESTS AND THEIR CONTROL

By Norman Criddle.

Field Officer, Dominion Entomological Branch.

The insect enemies of growing crops cause enormous losses every year. In Canada alone many millions of dollars are lost annually through their depredations. How best to prevent these attacks or to kill the insects before serious damage is done has been the study of economic entomologists for many years. The life-histories of the more common species found in Western Canada have been worked out, and in most cases preventive or remedial measures have been devised whereby serious loss may be partially or wholly avoided.

375. The Development of Insects.—With a few exceptions insects hatch from eggs deposited by the adult females. Upon hatching they are very little larger than the eggs and often bear very little similarity to their parents. By the uninitiated, it would not be readily imagined that the caterpillar is the immature stage of a butterfly or moth. On the other hand insects such as grasshoppers produce young that resemble the adult form very closely except for the undeveloped condition of the wings and differences in color markings.

As the immature insect feeds it grows, and as it grows it molts its skin. This may occur frequently during the young, undeveloped condition. In insects which undergo a *complete metamorphosis* there are two distinct stages between the egg and the fully mature adult. These are known as the *larva* (caterpillar, grub, maggot) and the *pupa* (chrysalis). The larval stage represents the period of active feeding and it is during this stage that the insect is most harmful, as for example, the armyworm. During the pupal stage the insect does not feed but apparently remains dormant. Really, however, there are great changes taking place inside the pupa whereby the adult, winged insect is formed. On emerging from the pupa the function of the adult is mainly confined to the perpetuating of the species. Such a series of transformations applies to butterflies and moths, flies, beetles and bees, all of which insects normally pass through four stages, of egg, larva, pupa, and adult.

In contradistinction to this mode of development is that of grasshoppers and bugs where the young are very much like the adult on emerging from the egg. At each molt they increase in size and small wing-pads make their appearance on the sides of the thorax. There is no pupa or resting period, the insect being able to move around during the whole of its career. When mature the fully-developed wings of the adult appear. The immature stages of such insects are called *nymphs*, so that all told there are but three stages, the egg, nymph, and adult. This development is called an *incomplete metamorphosis*. An accurate knowledge of the exact time and the conditions under which transformations

occur, has a strict bearing upon the method of control for any particular species.

376. Two Classes of Insects.—Insects may be divided into two large classes, according to the structure of their mouth-parts, (1) mandibulate, those having biting mouth-parts, and (2) suctorial, those which extract liquid nourishment from the tissues of their hosts. Biting insects may be killed by poisoning, while sucking insects must be killed by the application of some substance which suffocates by closing the breathing pores or kills by mere *contact*.

The methods of control may be grouped under two heads, preventive and remedial. The preventive methods are such as tend to diminish or prevent reproduction, while control measures aim at decreasing the damage after the insect has become established. In argricultural practice preventive measures have very often to be adopted. These should be applied at that stage of development of the insect which is most vulnerable.

In the following pages a brief description is given of the principal insects attacking field crops, fodder crops and vegetables, together with the best-known measures for their control.

377. Cutworms.—These are an early stage of what are properly termed "moth millers". They are cylindrical-shaped, worm-like caterpillars which attack many kinds of plants and cut them down close to, or just below the surface of the soil. The moths deposit their eggs among rubbish or in clods of earth. Rough, uneven soil is preferred by the Red-backed cutworm moth for egg laying, and the females select the higher land areas, avoiding the hollows. Thus it is that knolls may be literally swarming with young cutworms while the surrounding

portions of the field are comparatively free. Summer-fallow seems to be more infested than stubble land and this is especially so when the land is rough or over-grown with weeds. Bunches of weeds either standing or raked into heaps nearly always harbor cutworms. Old straw piles are also centres of distribution. The eggs of the Red-backed cutworm, which is by far the most widely distributed species, are laid in August and September, and the resulting grubs do not hatch out until the following spring. This is also the case with the Pale Western cutworm, so injurious a few years ago in southern Alberta. The Army cutworm, on the other hand, hatches the same fall that the eggs are deposited, as does the White cutworm. While there are many other kinds of cutworms this summary of the habits of the above-mentioned species is sufficient, in a general way, to cover them all.

Fig. 139.—Red Backed Cutworm Moth.
After Gibson.

Cutworms attain their greatest destructiveness during the middle of June. In years of excessive numbers they may remain almost to July, but many begin to pupate about June 20th. Very soon after this date the danger is over for the season. Most cutworms are only active at night, and it is during this time that they come to the surface of the ground in search of food. It is this habit that has made it possible for the entomologist to devise the best means of controlling them.

378. Prevention of Cutworms.—(1) Avoid having weedy summerfallows. Certain cutworm moths un-

doubtedly lay their eggs on weeds, while others do so among them. Unless there are clumps of weeds in which they can hide, or clods of earth to shelter them, the moths are not nearly so apt to lay their eggs in the fallow.

(2) Keep the land as smooth as possible in order to eliminate the hiding places of the moths, for reasons given above. The farmer must, of course, use his judgment in cultivating in order to prevent soil drifting.

379. Control Measures for Cutworms.—(1) Watch the knolls about the first week in June and examine the ridges or small elevations of land. If there are cutworms anywhere on the field, they should be found in greatest numbers in such places.

(2) As soon as cutworms are located in destructive numbers apply the following poisoned bait:

Shorts or bran	50 pounds.
Paris green	1 pound.
Molasses	1 gallon.
Water	1½ gallons.

White arsenic, which is cheaper than Paris green, may be substituted for it. It is, however, not so rapid in its killing power.

In preparing the bait, mix the poison with the shorts or bran while dry, add molasses to the water and thoroughly mix all together so that the mash becomes crumbly and will not stick together in lumps. This should be applied as late as possible in the evening, preferably after sunset, so that it will still be moist when the cutworms come out to feed. It should be scattered wherever the grubs are numerous, using the above amount for not less than an acre of land. If applied in time, before the cutworms crawl from their breeding

places, 50 pounds of shorts may be sufficient to control the infection over many acres of crop.

(3) In addition to the above measures, it is often advantageous to plow a deep furrow around the infested knolls. This should be done in such a manner that the furrow is turned away from the advancing insects.

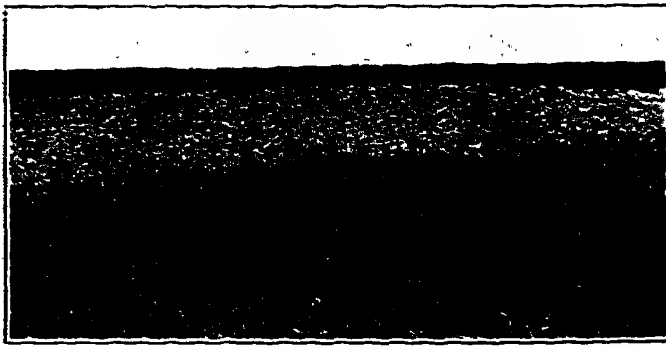

Fig. 140.—Fall Wheat Destroyed by Pale Western Cutworm. Showing characteristic damage to a slightly elevated spot.—After Strickland.

Hundreds of cutworms will make their way into such furrows and can then be easily destroyed by means of poisoned bait.

In gardens a shallow ditch made with a hoe around the beds will prove of considerable value in protecting the plants within. Plants grown in a hollow such as is recommended for sweet peas, will on the other hand be liable to much greater injury than if they had been planted on the level.

(4) The well known method of protecting individual plants by means of collars is valuable in gardens. This consists in using a piece of tin or wire screening cut in lengths of about 6 inches by 3 inches wide. This is

twisted around the young plant to be protected so that the ends meet and the base of the collar is about an inch below the surface of the soil. Many valuable plants can be saved by this means at comparatively small cost.

380. The Army Cutworm.—This insect has been dealt with very fully by E. H. Strickland in Bulletin No. 13 of the Dominion Entomological Branch and the following details have been taken from that work. Injury caused by this species has been largely confined to southern Alberta and Montana, though it occurs eastward throughout the Prairie Provinces. The eggs are deposited in the soil during autumn, rough summerfallow being especially attractive for that purpose. The young grubs hatch the same season and attain about a third of their growth before winter sets in. In the spring they become active as soon as the soil warms up and attack such herbage as is available. A scarcity of food at once starts them marching, and in years when they are abundant thousands of them may be observed crawling in a northwesterly direction in

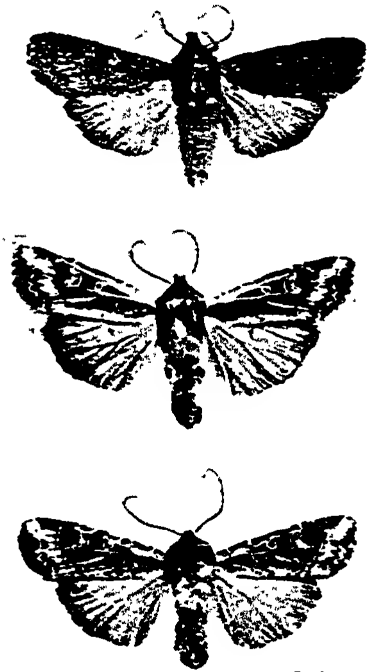

Fig. 141.—Army Cutworm Moths. Showing three varieties, natural size. After Strickland.

search of new pastures. Pupation commences towards the middle of May and by about June 10th nearly all will have reached the pupal stage, and the attack will therefore be over. Army cutworms differ from ordinary cutworms by feeding on the surface instead of burrowing near their food and eating it beneath the surface of the ground.

331. Control of the Army Cutworm.—As the army cutworms are already active when the farmer is preparing for, or actually engaged in seeding, and may be very

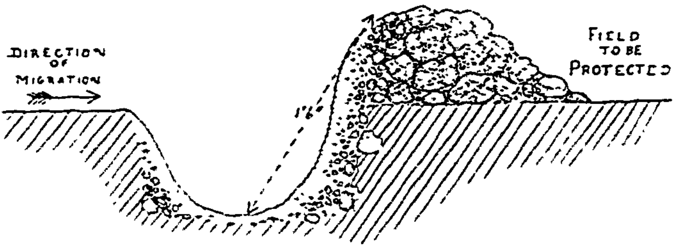

Fig 142.—Diagram of a Dusty Side Furrow.
After Strickland.

plentiful on the fields being worked, some scruples may be entertained as to the advisability of undertaking measures of control. Since, however, there is generally a week's interval between sowing and the appearance of the growing crop, a portion of this period may well be utilized for this purpose.

One should first make sure of destroying all growing plants. This will induce the caterpillars to seek food elsewhere and start them marching. Then, to quote Mr. Strickland, "Turn as deep a furrow as possible with a walking plow, throwing the earth towards the field to be protected. This should be sufficiently deep, so that the distance from the crest of the ridge to the bottom of the

furrow is at least a foot. Now drag a heavy log down the furrow. The man who is in charge of the horses, should stand on the back end of the log to weigh it down. This operation will crush all the large clods and leave a smooth, dusty, sloping side to the furrow."

Furrows such as these should be prepared every forty rods in badly infested fields and directly ahead of the line of march. Such furrows will hold the caterpillars sufficiently long to permit poisoning them by either the poison bait mentioned above (Sec. 379) or by some prevalent weed, such as stink weed, steeped in Paris green as follows: Moisten 50 pounds of the weed and then dust in one pound of Paris green, turning the mass constantly so that the poison is evenly distributed. Scatter the weed thus treated along the furrow about every eight inches, preferably in the evening.

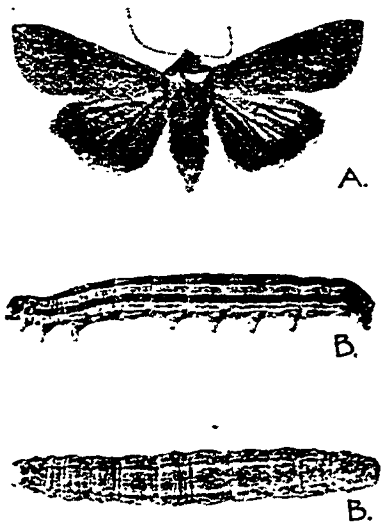

Fig. 143.—Army-worm Moth and Larva. (A) Army-worm moth, after Gibson. (B) Army-worms, redrawn after Riley. Natural size.

382. The Army Worm.—The army worm has not, as yet, been a serious pest in Western Canada, though local outbreaks in Manitoba a few years ago show that the insect might become one under favorable conditions.

The moth is rather more than an inch and a half across

the wings. The upper wings are almost fawn-colored with inconspicuous black marks and a characteristic white dot towards the middle of each.

The caterpillar, with which we are chiefly concerned, is approximately an inch and a half long when fully developed, and its color pattern is made up of several greenish, light yellow, brownish or almost black stripes, there being much variation in the color scheme. These caterpillars hatch in low spots in fields instead of in the higher elevations as do the cutworms. There are two broods, but the first is not of great importance. The caterpillars are seldom noticed until they are nearly full grown, at which time (August) they assume the marching habit and swarm across fields, devouring nearly everything in the line of march. They begin to migrate towards evening in a westerly direction.

383. Remedies for the Army Worm.—(1) Plow a deep furrow ahead of the line of march as suggested in Section 381. This should be about a foot deep with the

Fig. 144.—Egg Pods of Locusts; Pod at Right Opened to Show Eggs. After Gibson & Criddle.

straight edge cut clean so that the caterpillars cannot crawl out. About every 15 feet holes as for posts should be made for the insects to fall into when they can be killed by pouring a little coal oil over them, or they may be crushed with a post.

(2) Poisoned bait similar to that recommended for cutworms is also effective, and should be applied when the caterpillars are active. For very full details relating to this pest see Bulletin No. 9 of the Dominion Entomological Branch, by Mr. Arthur Gibson.

384. Locusts or Grasshoppers *—While it is a number of years since there has been an outbreak of locusts, it is well to remember that these insects have in former times caused enormous damage and that in the seventies they practically devoured all green vegetation in their way, including the leaves of trees. There have been lesser outbreaks in more recent times which have exacted toll from the farmer, and should conditions be favorable there is every reason to believe that there will be others in the future.

The eggs of locusts are deposited in a kind of pod constructed by the female insect as she oviposits. These pods, in the case of the Lesser Migratory Locust, contain about 16 eggs. The pods or egg sacs of the Two-striped Locust contain, at times, over a hundred eggs. Surrounded by their covering the eggs are placed in the ground so that the lower extremity is rather more than half an inch below the surface and the upper portion reaches almost to the top. Stubble, grasslands, or deserted fields all form ideal breeding grounds. In these the eggs are deposited. Young locusts undergo several molts before they attain wings, and the best time to fight them is before they are able to fly.

385. Remedies for Grasshoppers.—(1) Plow egg-infested areas deeply at any time before May 1 and pack the land so that the young locusts cannot make their way through the surface. Discing is useful in breaking up the egg sacs but it is much less efficient than plowing.

*Written before the serious outbreak of 1919.

(2) Apply any of the standard poisoned baits. In Manitoba the so-called Criddle mixture proved very efficient during the last locust outbreak. It is made by mixing the following ingredients:

Fresh horse droppings	50 pounds.
Paris green	1 pound.
Salt	1 pound.

Enough water to moisten the contents thoroughly.

The advantage of this mixture is that it is very cheap and has the additional value of being attractive to the insects long after it has become dry.

Another mixture, known as the Kansas bait, is made as follows:

Bran	40 pounds.
Paris green	1 pound.
Molasses	4 quarts.
Lemons	6
Water	5 gallons.

Mix the bran and Paris green while dry, then squeeze the juice of the lemons into the water and cut up finely. Add the pulp, then stir in the molasses and mix the whole together until the contents become crumbly.

Another bait that should be mixed like the last is made up of the following:

Sawdust	40 pounds.
Paris green	1 pound.
Salt	1 pound.
Water	6 gallons.

Of the three the Kansas bait is probably the most effective, but it has the disadvantage of being more costly. These mixtures should be applied during the morning, preferably on a sunny day, when the temperature is

about 60 degrees F. in the shade. They should be scattered thinly wherever locusts are plentiful.

386. Protecting Twine from Locusts and Crickets.—For the protection of twine against both locusts and crickets the following solution has been found useful:

Bluestone (Copper Sulphate)	1 pound.
Water	6 gallons.

Soak the balls of twine in this solution for half an hour and dry thoroughly before using. This treatment rather weakens the twine and adds to the difficulty of harvesting, but is, nevertheless, very useful when the insects are numerous.

387. The Beet Webworm (*Loxostege sticticalis*).—A dark striped caterpillar which sometimes causes a great deal of alarm to farmers in July and is occasionally mis taken for the Army worm. These insects seem to multiply very rapidly, and suddenly assume the marching habit, usually moving in a northwesterly direction. They rapidly eat up all broad-leaved plants in their line of march and wreck any garden that they happen to encounter. In this progress they also eat the lower leaves off trees, crawl up houses, and otherwise make themselves obnoxious. Then, when it appears as if they were likely to strip the ground of vegetation, they enter the earth to pupate and disappear as suddenly as they came. Fortunately these caterpillars seldom eat growing grains and grasses, hence there are times at least when their march through a grain field is actually of some benefit, as the weeds are eaten while the grain is left untouched.

For the protection of gardens or larger fields, a trench similar to that described for Army cutworms (Sec. 381) can be made and in it should be scattered

weeds, (preferably red root pigweed (*Amaranthus*), or, if this is not present, lamb's quarters) which have been poisoned with an arsenical insecticide.

383. Hessian Fly.—Hessian fly attacks usually follow two or more years of excessive moisture. In the Prairie Provinces they are few and far between owing to the somewhat dry climate. The insect, however, continues to survive and it is in reality fairly wide-spread. There are two partial broods in this country. The adults from one brood emerge from over-wintering pupae in May, and the others emerge from spring pupae in early July. The spring attacks occur close to or below the ground and the greenish-white grubs are to be found clustered around the base of the plant behind the sheaths. A more bluish appearance than is usual indicates that the plant is being attacked; later the leaves turn yellowish brown and die.

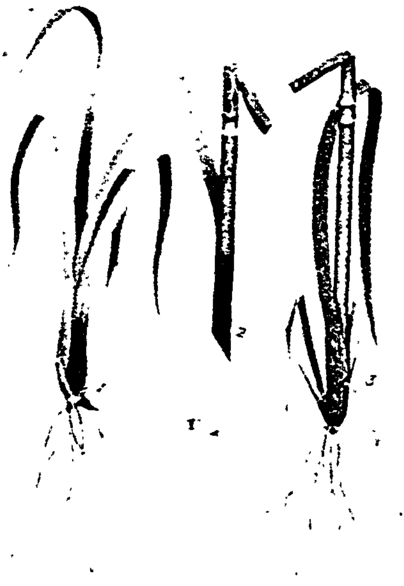

Fig. 145.—Showing Typical Injury by the Hessian Fly.

(1) Spring wheat plant destroyed in early June, with puparia or "flax seeds" near the roots; (2) part of a wheat plant in late July with sheath removed showing puparia above the second joint; (3) characteristic bending of the stem caused by the summer brood; (4) adult fly.—After Criddle.

The second generation is distinguishable at once by the characteristic bending of the stems, usually just above the second joint. The place of breaking is always within half-an-inch of the joint, and an examination will reveal one or more puparia, commonly termed "flax seeds," embedded in the straw behind the sheath. Wheat and barley are the two chief crops attacked. Oats appear to be quite immune.

389. Remedies for Hessian Fly.—(1) Plow down deeply all stubble between August 12 and May 1st of the following spring and pack the soil.

(2) Burn all rubbish and straw piles, when these cannot be utilized before May 1st. Screenings from the threshing machine should be destroyed as they may contain many puparia.

390. Grass-stem Maggots.—These insects in the adult stage are small, insignificant-like flies. They lay their eggs upon the leaves of growing grain, grasses, and even decaying vegetation. The eggs give rise to whitish maggots which work their way down behind the sheaths and eventually destroy the central sprout. With one exception, the chief injury is effected during the spring time. The patchy appearance of grain fields is often due to these insects. The adult of the Greater Wheat-stem Maggot, which is rather larger than the rest, is greenish in color, with dull black stripes. This produces a second generation which attacks the grain just above the topmost joint causing the well-known "white heads". Any whitish stem that is easily pulled away at the top joint can be reasonably classed as having been killed by this kind of insect.

391. Remedies for Grass-stem Maggots.—Deep plowing in fall and spring of infested stubble, and the destruc-

tion of volunteer growth are the two chief measures to be recommended. Western rye grass proves a specially attractive breeding medium for all of these insects. Oats are seldom attacked, hence they may often be sown to advantage, especially on newly broken grass fields.

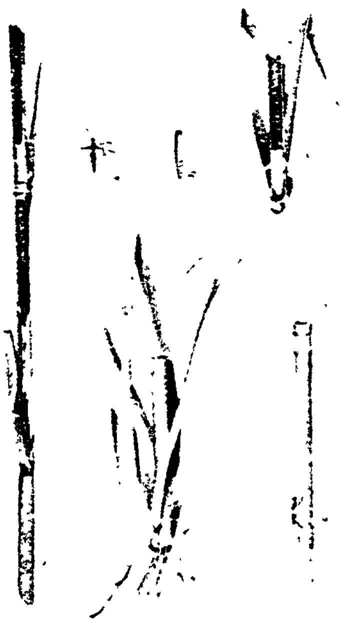

Fig. 146.—The Western Wheat-Stem Saw-fly.

(1) Straw cut open to show tunnelling of larva, (2) base of plant showing how stem is severed near ground, (3) stub with larva in winter position, (4) portion of stem showing characteristic resting attitude of saw-fly (5) female saw-fly; (6) mature larva. About one-half natural size.—After Criddle.

392. Western Wheat-stem Saw-fly.—The adult is a slender wasp-like insect which is generally found resting head downwards upon grains and grasses towards the middle of June and early July. These flies deposit their eggs in the stems of the above-named plants, and from these eggs there develop white larvae distinguished from other grain-infesting insects by a distinct thorn-like point at the posterior end of their bodies. The larvae immediately commence to eat out the inner tissues of the stem and as time goes on, work their way downwards through the joints until they reach the base of the plant at the end of July. Shortly afterwards they gnaw a ring

around the inside, causing the stem to break at that point. Then having plugged the top of the stump with silk-like material, they remain within until the following June, when they emerge as fully-developed adults. Injury to grain can be at once recognized by the tunnels penetrating the joints and by the large amount of dust-like gnawing left behind.

Edges of fields, or those portions adjacent to the last season's crop, are always most severely attacked, and the injury diminishes as the distance from these increases. This is explained by the fact that the flies oviposit upon the first suitable plant that they encounter.

393. Remedies for Western Wheat-stem Saw-fly.—(1) Plow all infested land not less than five inches deep between August 1st and June 10th of the following year and take precautions that the land is well packed afterwards to prevent flies forcing their way through.

(2) Cut all infested grasses between July 10th and 30th. This measure will serve to catch the larvae in the stems before they reach the ground and so cause them to dry up.

There are no other reliable remedies, but since wheat and rye are the two cereals chiefly attacked and oats are immune, it might sometimes be a wise course to substitute the latter for one of the former. When the saw-flies are known to be bad, severely-damaged grain can be gathered up with a horse rake and much of it saved by this means.

394. Wireworms.—These are brownish-yellow, tough and wiry worms which eventually change to click beetles. There are several kinds known to cause injury to cereals and root crops. The attack is always most severe on

land that has grown grass, especially rye grass or timothy, and will continue for two years after these grasses have been broken up. There are no remedies known, and one has therefore to resort to preventive measures as much as possible. These consist in breaking up grasslands in early summer, not in the fall or spring, and in avoiding the sowing of wheat, using in its place some quick-growing grain, such as oats, rye or flax. It is also advisable to sow rather more thickly than is customary on ordinary land.

395. White Grubs.—Large, more or less curled, white grubs with yellow heads are found in the vicinity of wood-lands. The parents of these are large brown beetles or "thunder bugs." The grubs attack the roots of nearly all kinds of plants well below the ground. The beetles, on the other hand, devour the leaves of trees. There are no specific remedies, but much can be done to reduce losses by adopting the following measures:

Plow land about four inches deep between May 10th and 20th. By this means many grubs are exposed and are picked up by crows, blackbirds and gulls. This also destroys the eggs. Like wireworms, these grubs are especially numerous on grass lands. They burrow down below the frost line in early October and do not appear again before May, hence plowing between those dates will prove ineffective in controlling them.

396. Grain Aphids.—These are soft, greenish insects found at times in enormous numbers on all kinds of growing grain but especially upon oats. There is no practical remedy for these, and in any case the injury attributed to them does not seem to be very great. As a rule they are not troublesome two seasons in succession,

owing to climatic conditions and to the rapid increase of their insect enemies, such as lady-bird beetles, lace-winged flies, *Syrphus* or "hover" flies and small hymenopterous parasites.

397. The Imported Cabbage Worm.—This green caterpillar attacks cabbages, turnips and smaller plants. The adults are the white butterflies, which may be seen flying in the vicinity of the above-mentioned plants. They are in reality busily engaged in laying eggs, and their presence is a sure indication of a coming attack.

398. Remedies.—Spray with Paris green, ¼-pound to 40 gallons of water or with dry arsenate of lead, 2 pounds to 40 gallons of water, and add a "sticker" made by boiling together, for about an hour, 2 pounds of resin and one pound of sal soda (crystals) in one gallon of water. This stock solution is sufficient for making 40 gallons of the insecticide.

When the plants begin to develop heads the use of poisonous insecticides should be avoided, and Pyrethrum insect-powder should be substituted. Mix the powder with 4 parts of flour and permit the mixture to stand for 24 hours before using; apply the dust by shaking through a double ply of cheese cloth either in the early morning or in the evening. Probably two or more applications will be necessary. It is advisable to keep pyrethrum powder in an air-tight box, otherwise it will deteriorate very rapidly.

399. The Red Turnip Beetle.—This is a red beetle with black stripes. The larvae feed upon the roots of cruciferous plants and the adults upon the foliage. At times they are quite destructive to turnips and cabbages. They should be sprayed with Paris green or arsenate of lead as recommended for the control of cabbage worms.

400. Colorado Potato Beetle.—The abundance of this insect is largely governed, in the Prairie Provinces, by winter conditions. Cold, snowless periods destroy large numbers of the hibernating beetles, whereas an abundance of snow protects them.

Potato plants should be carefully watched for indications of possible infection soon after they appear above the ground. When only a few adults are present, they should be carefully collected and destroyed. By this means much future trouble and loss will be avoided. When the insects are numerous, one of the following spray-mixtures should be applied two or three times during the season:

(1)	Dry arsenate of lead	1½	pounds.
	Paris green	8	ounces.
	Water	40	gallons.
(2)	Paris green	1	pound.
	Dry slaked lime	1	pound.
	Water	80	gallons.

Paris green is frequently used without water in the strength of one pound mixed with 20 pounds of land plaster or slaked lime, the plants being dusted with the mixture early in the morning when they are wet with dew.

401. Blister Beetles.—There are several species of these beetles one of which is sometimes termed the black potato beetle on account of its habit of feeding upon this plant. Another of larger size is of a brilliant winecolor; this is Nuttall's Blister Beetle, sometimes called Caragana beetle. All feed upon members of the pea and bean family as well as other plants. During their earlier stages they are active in devouring the eggs of other in-

sects and are especially valuable because of their habit of destroying locust eggs. When these beetles occur in sufficiently large numbers to become troublesome, they may be treated in a similar way to potato beetles.

402. Onion and Cabbage Root Maggots.—These are white maggots which attack the roots of onions, cabbages, radishes, turnips, etc. Two different insects are involved in causing this injury, but they are too much alike to be separately described with advantage in a brief statement. These maggots are the early stages of small, rather hairy flies which lay their eggs around the bases of the plants to be attacked. According to Gibson and Treherne (Bulletin No. 12 of the Dominion Entomological Branch) injury may occur from May until autumn. In the Prairie Provinces the chief damage is done in June and July.

Fig. 147.—Infected Cabbage Root.

Showing cabbage maggots in position.—After Gibson and Treherne.

403. Remedies for the Cabbage Maggot.—All rubbish and infested plants such as cabbage stumps and old radishes should be cleaned up, and, where possible, the location for these crops changed. Discs made of one-ply tarred paper should be used. These are about three inches in diameter with a straight cut to the centre and a few nicks to permit the disc to fit closely around the

young cabbage or cauliflower plant and yet not interfere with growth. The most essential point to remember in using these discs is that one should place them around the young plants immediately after the latter are planted out in such a way that they will fit tightly and lie flat

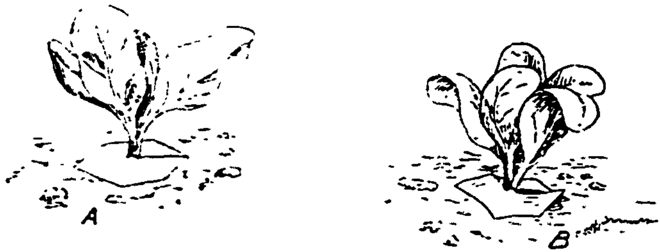

Fig. 148.—Protective Discs for the Cabbage Maggot.
A, shows a correctly placed one; B, one carelessly arranged.—After Hewitt.

on the ground. Remarkably successful results have followed the adoption of this practice.

404. Control of the Onion Maggot.—This fly is even more difficult to control than the last, but some experiments have recently been conducted which have proved very successful. The one which appears to give the best results is that in which the following spray mixture is used:

Sodium arsenite	4	ounces.
Molasses	1	pint.
Boiling water	1	gallon.

Dissolve the sodium arsenite in the water and afterwards add the other ingredients. Apply the mixture to the plants with a small-rose watering can at any time during the day when the temperature is above 60 degrees F. The idea is not to kill the maggots but to attract the flies to the sweetened poison before they lay their eggs.

There is a period of from about 10 to 14 days after the female flies emerge until they commence to lay their eggs, during which they are easily attracted to the molasses and killed by the poison. It is not necessary to spread this over the entire crop. It shoud be applied to rows about 15 to 20 feet apart.

Unfortunately, seasonal climatic variations render the exact time of the appearance of the flies uncertain. As a rule, however, they may be expected during the last week in May when the plants are about three inches high. Three or four applications of the poison, each about a week apart, are advisable.

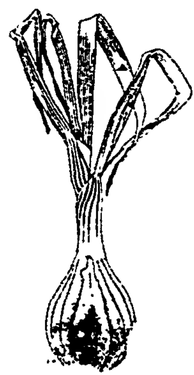

Fig. 149. — Onion Destroyed by Onion Maggot.

After Gibson and Treherne.

405. Currant Saw-fly.—These are black-spotted, greenish, false caterpillars in which the hind part of the body turns up. They are often found infesting currants and gooseberries. Spray with Paris green or dust with Hellebore, 1 part to 4 parts of flour.

406. Insects of Minor Importance in the West.—Several insects that have, so far, proved of lesser importance may be mentioned on account of the possibility of their becoming prevalent at some future time. Among these are the *Wheat Midges, Pea Weevil, Plant Lice and Thrips.*

407. Wheat Midges.—The adults are minute flies. The injury is caused by the larvae, which are reddish maggots found clustered inside the chaff and around the growing kernels, causing the latter to shrivel up. While we have no records of injury in the Prairie Provinces, occasional heads have been found to be attacked, and the

insect occurs in destructive numbers both east and west of Manitoba. The prescribed remedies are similar to those recommended for Hessian Fly.

408. The Pea Weevil.—A small, roundish, dull-colored beetle which passes its grub stage inside the peas and emerges from them, as a beetle, in late fall or early spring. Enormous damage has been done by this insect in eastern Canada, but it has rarely been found in the West. Methods of control consist in carefully treating the seed, preferably fumigating it with sulphide of carbon, three ounces to five bushels of peas in a barrel with a tightly-fitting cover. Pour the liquid upon the seed and leave the barrel closed for 48 hours. Great care should be exercised to keep all lights away from the vicinity of the receptacle. Even a lighted pipe may cause the vapor to explode. Holding the peas in tight sacks for a year will also prove an effective measure of control.

409. Plant Lice, or Aphids.—These are variously colored, soft-bodied insects which cluster upon leaves and stems of plants from which they suck the juices. Efficient control can be attained, as a rule, by the use of contact sprays, such as the following:

Black leaf "40"	1-3 pint.
Soap (to be dissolved)	2 pounds.
Water	50 gallons.

Another well-known spray is kerosene emulsion prepared as follows:

Kerosene	2 gallons.
Soft water	1 gallon.
Soap	½ pound.

Dissolve the soap in boiling water, add the kerosene,

and churn until the whole becomes a creamy liquid. Add about 9 gallons of water before using.

410. Thrips in Oats.—These minute insects are widely distributed and, at times, have occasioned severe damage to oats by causing sterility of the flowers usually at the base of the head.

The attack occurs just about the time that the plant is heading out and is distinguished by the white shrivelled-up apearance of the glumes.

Fig. 150.—Oats Damaged by Thrips.
Showing sterile spikelets caused by Thrips. After Hewitt.

Control measures, as suggested by Dr. C. G. Hewitt, consist in early seeding, using quick maturing varieties of oats, deep plowing and the destruction, by mowing, of all grass heads before they leave the sheath.

Thorough and careful preparation of the soil is as essential in the war against insects as it is against weeds. Anything that can be done to stimulate the growing crop will aid materially in reducing insect depredations.

CHAPTER XV.

SOME OF THE MORE IMPORTANT DISEASES OF POTATOES

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The many diseases which affect the potato crop may be divided into four general classes, depending upon the nature of the trouble and the means by which it may be controlled. It is essential that one should be able to recognize each disease before the proper control measures can be applied, because what proves effective for one pest may be found useless for another.

411. Four Groups of Potato Diseases.—To the first group belong the two blights, known as the early and late blight; these attack the leaves, producing dead areas on them and in many cases finally killing them. They are caused by parasites which are carried through the air from the foliage of one plant to another, and they may be prevented by covering the leaves with a protective poisonous coat. This is done by spraying the plants with Bordeaux mixture.

In the second type of diseases the parasite may be carried for the most part on the surface of the seed, but it may also in certain cases persist in the soil as well.

The black leg disease is, for instance, carried very largely in the seed, it being doubtful if it ever lives over in the soil from one season to another. On the other hand such well known pests as common scab and black speck (or Rhizoctonia Disease) are perpetuated not only by means of scabby and specked tubers, but the parasites live in the soil and are naturally present even in some virgin land. The general course of treatment to be followed in this case is a disinfection of the potatoes before they are cut for seed, preceded in the case of black leg by a careful selection of the tubers, and the exercise of care in cutting to discard any which show rot inside.

The wilts comprise the third group of diseases. The trouble is caused by a parasite in this case and the infection is carried over from one year to another by means of the tubers, but it is entirely within the potato and cannot be reached by disinfectants. The disease may be easily eliminated by the use of seed from a wilt-free crop and by using care in cutting the seed to reject entirely any potato which has brown marks in the flesh.

In the diseases of the fourth group no parasites are known but there is a deep-seated disturbance of the constitution of the plant which is in every case carried over into the succeeding year through the tubers. There is no sign of rot on any part of the plant or in the crop, but the yield is seriously reduced and the top is wanting in vigor. In such cases, as will readily be seen, tuber selection and disinfection are useless. The course of treatment to be followed is to obtain seed from a disease-free crop. This may be achieved in some case by selecting seed from healthy plants in partly affected fields, but if any of the diseases are present to a serious extent

it may be necessary to import healthy seed, preferably from a district in which these pests do not occur.

412. The Description. Cause and Control of the Chief Potato Diseases.—The various types of diseases and their appropriate treatments are summarized in the table on pages 388 and 389.

413. The Blights and Tip Burn.—None of these diseases have proved of any economic importance in the Prairie Provinces and it is unlikely that they will in the future, since they have not done so under similar climatic conditions in the United States. It will be no harm, however, to be able to recognize them on account of the great damage they cause in other parts of Canada. Both blights make their appearance first in the form of scattered dead spots on the leaves, the early blight being distinguished from the late blight owing to the spots being marked with a series of darker colored rings like a target. If the weather is moist the late blight in particular may spread very quickly and completely destroy the tops. The late blight is also responsible for the commonest rot of the tubers in the field and in storage, the infection being washed down from the diseased foliage through the soil by rain. The rot in the tubers is typically a dry brown rot underneath the skin, but secondary wet rot not in-

Fig. 151.—Late Blight Rot. Showing external view of tuber affected by this disease.

frequently follows. Early blight does not affect the tubers in any way.

Tip burn is due solely to the action of very hot sun in scorching the edges and tips of the leaves. The injured portions become dry and crisp and they will be noticed particularly on the exposed leaves during very hot weather. If the injury is prolonged a considerable portion of the foliage may be destroyed. For reasons not *sufficiently under*stood spraying the foliage with Bordeaux mixture acts as a very considerable protection against tip burn.

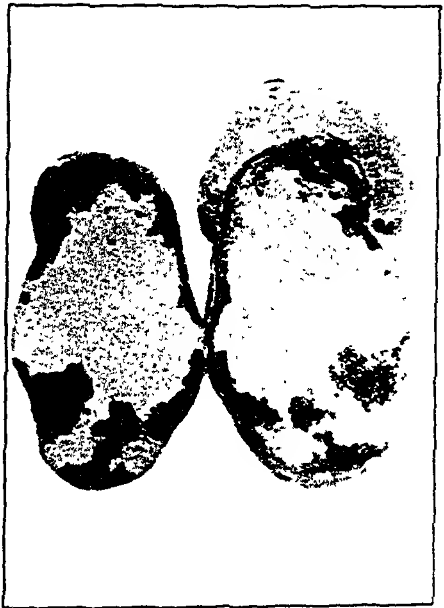

Fig. 152.—Late Blight Rot.
Showing internal view of tuber affected by disease.

Bordeaux mixture is made by *dissolving 4 lbs. of* Copper Sulphate in 2 gallons of water, (hot water hastens the solution) in a wooden vessel. The solution is then poured into 36 gallons of water *in the tank* of the sprayer, which generally holds 40 gallons. In the meantime 4 lbs. of good stone lime is slaked in a separate vessel, stirred up when slaked into a milk in 2 gallons of water, and then strained into the tank of the spraying machine.

Name of disease	Caused by	Description of disease in tops	Description of disease in tubers	Carried by	Control measures
Late blight	Parasitic mould	Purplish black or dark brown dead spots on leaves. The spots may have a yellowish green margin and show mildew on lower side of leaf.	**Exterior** Shrunken hard areas of livid colour. Sometimes concealed by wet rot which follows. **Interior** Rusty brown marks in flesh beneath skin.	Wind, rain, etc., from plant to plant and finally to the tubers, by which it is carried over to the next year.	Controlled by thorough spraying with Bordeaux mixture.
Early blight	Parasitic mould	Yellowish dead spots on leaves marked with darker rings like a target.	Does not attack tubers.	Wind, rain etc., from plant to plant and to the soil, where it persists.	do.
Tip burn	Hot sun	Tips and margins of exposed leaves turn brown, curl up and die.	Does not attack tubers.	Does not spread.	Reduced by spraying with Bordeaux mixture.
Black leg	Parasitic bacteria	One or more stalks of plant turns yellow and wilts. Stem below ground black and rotted. Set also rotted.	Soft white rot sets in at stem and eats out centre of some of the tubers.	Partly rotted or externally infected but sound tubers.	Careful selection of sound seed tubers followed by disinfection as given below.
Black speck or Rhizoctonia disease	Parasitic mould	Top leaves of plant look like rosette. Stalks thicken and tubers may be carried above ground. Deep scars on stem below ground.	Small, earth-coloured specks on surface of tubers which turn black when wetted.	Infected soil and by tubers with black specks.	Disinfect seed potatoes before cutting by steeping for two hours in either 4 oz. corrosive sublimate, or 1 pint formalin in 30 gallons water. (Former is poisonous; use it in wooden vessel only and with care.)
Common scab	Parasitic mould	Does not affect tops.	Rough brown scars on tubers.	Infected soil and by scabbed tubers.	

Wilt	Parasitic mould	Foliage turns yellow and wilts. Brown discolouration in base of stalk *beneath skin*, but no rot as a rule. Set usually sound.	Browning extends considerable distance into flesh of some tubers at stem end. No rot.	Tubers with browning at stem ends.	Select seed in field from healthy plants. Discard all tubers *with brown marks* in flesh while cutting.
Leaf roll	Cause Unknown (Constitutional disease)	Plants dwarfed and of unhealthy colour. Lowest leaves rolled up, leathery to touch and dying from tips backwards.	Very small yield. Tubers formed close to main stem. They show no signs of disease.	Spreads sometimes from plant to plant in field. Always carried over by tubers.	Select seed in field from healthy plants. If crop is seriously diseased procure healthy seed from a non-infected crop. *Avoid seed from* districts liable to *leaf roll*.
Mosaic	Cause Unknown (*Constitutional* disease)	Leaves puckered and mottled *with faint* light green spots. Plants may be distorted and *dwarfed. Lower leaves fall* early.	No sign of disease in tubers.	May spread somewhat in field. Practically always carried over by tubers.	do.
Curly dwarf	Cause Unknown (Constitutional disease)	Plants strongly dwarfed. Leaves huddled close to main stem. Normal in colour. Plants die early.	Extremely small yield. No sign of disease in tubers.	Always carried over by tubers.	do.

This makes 40 gallons of 4: 4: 40 Bordeaux mixture. Poison for the Colorado beetle may be added to Bordeaux mixture where this is needed. Any of the following poisons may be used in the amounts stated in 40 gallons of spray: Arsenate of lime (powder) 1½ to 3 lbs.; Arsenate of lead (paste) 2½ to 5 lbs., (powder) 1½ to 3 lbs.; Paris green 1½ to 3 lbs.

It is generally necessary to spray four times at intervals of two weeks, beginning when the plants are about eight inches high. It is advisable to maintain a pressure of 100 lbs. to the inch to get the best results and to use at least two nozzles to each row. If the machine cannot do this the field should be sprayed over twice in opposite directions the same day. In either case, about 80 gallons of spray will be used per acre.

Fig. 153.—Plant Dying from Blackleg.

414. Black Leg.—In certain years this is the most destructive disease of potatoes occurring in the Prairie Provinces. In many cases the plant is killed by it at so young a stage that a miss is the result, while in others it may grow for a considerable time, to be eventually destroyed with the greater part of its crop. Thus a considerable amount of unevenness of the crop may be attributable to this cause. Affected stalks are readily pick-

ed out by their yellow color and drooping appearance. On pulling such a plant up the stalk will be found to be rotted below the ground and sometimes for some distance above it. The tubers may also be attacked. The disease works into them generally along the stem on which they are borne and sets up a soft, light-colored rot within them. As a rule when one stalk in a hill begins to go the others will eventually die also.

The cause of black leg is a species of bacterium which works from the set into the stalk, rotting both as it progresses. The character of the soil, temperature and rainfall have a marked influence on outbreaks of the disease. Cold and wet soil seems to favor it, possibly the cold more than the moisture. This is the reason why black leg appears in varying amounts in different years, for it is only when conditions are right for its development that the pest can show itself in any quantity. On the other hand sufficient is present in any year to tide it over to the next.

Black leg is carried over from year to year principally, if not entirely, by the seed. Tubers in which the rot has been arrested, or others which have been externally contaminated, particularly in deep cuts and bruises, have been proven to be the source of infection for the succeeding crop. There is no evidence that it persists in the soil. Control measures are based on this fact and general success has followed their adoption. (See Sec. 412). Attention is directed to the necessity for careful selection of the tubers, without which the treatment will not be effective. It is also advisable not to attempt to use seed from a crop which was very badly diseased or in which misses were abundant.

415. Black Speck, or Rhizoctonia Disease.—This is another very serious disease of the western potato crop. It frequently attacks the sprouts while still below the ground and girdles them. A lateral shoot is then thrown out and this may in turn be attacked. The failure of some plants to grow and the weakness of many others, which may be readily picked out owing to their small size and rough foliage, is attributable to attacks of Rhizoctonia on the stem. When a large plant is suffering from the disease the topmost leaves have a characteristic appearance much resembling a rosette. These leaves may be reddish in color but the plants do not turn yellow or die. Such plants generally have the stalks thickened abnormally and a number of lateral shoots will be found on the main stem. It frequently happens also that tubers are formed above the ground, particularly in severe cases. If such plants are pulled up the underground portion of the stem will be sound but it will be found to be deeply marked with the brown scars of the Rhizoctonia fungus, which is the cause of the trouble. The crop is frequently very small and often consists of a number of very small potatoes.

Fig. 154.—Rhizoctonia. Showing earth colored sclerotia of Rhizoctonia on a tuber. These carry the parasite over the winter.

The cause of these disturbances is a parasite which is carried in the little earth-colored specks commonly found attached to the skin of potato tubers. It is also a normal inhabitant of many soils. When it comes in contact with

a potato stalk in the soil it attacks it on the surface producing a characteristic hard brown scar. The downward supply of food to be stored in the tubers is more or less interrupted, which reduces the crop and causes the symptoms above described. The damage is liable to be more complete the earlier the attack takes place.

Fig. 155.—Damage by Rhizoctonia.
Showing shoots of young plant attacked below ground, and in some places girdled by Rhizoctonia.

Control measures consist of killing the parasite if it is present on the potatoes to be used for seed, because when present on the set it is very favorably situated for attacking the young sprouts. The disinfection method (using corrosive sublimate) given in section 412 will be found effective for this purpose. Since the disease also flourishes in some soils it is necessary to exercise care and not plant potatoes in such places as it is obvious that disinfection of the seed alone will not be effective under

these circumstances. There is no practical remedy for dealing with infected soil.

416. Common Scab. Common scab attacks only the tubers. It is responsible more than anything else for disfiguring the crop but it does not reduce the yield. It is carried over from year to year not only by affected seed but it persists in the soil as well. If the soil is not liable to produce a scabby crop, diseased seed may be rendered quite harmless by either disinfection methods indicated in Section 412 and a clean crop will result. If on the other hand the soil is infected to a serious extent disinfection of the seed cannot be expected to rid the crop of the disease. Not only should the seed therefore be disinfected but care should be taken to avoid land known to be liable to produce scab. There is no practical method for dealing with infected soil, but the avoidance of applications of manure on the potato crop will help to reduce the disease.

Fig. 156.—Common Scab on Tuber.

417. Wilt Diseases. Wilt is apparently not uncommon in the Prairie Provinces and it does a good deal of harm wherever it is found. Plants which are attacked by it look very much like black leg plants. The foliage turns quite yellow and flags and the whole plant dies in a short time. The underground portion of the stalk, however, will be found to be sound as a rule and the set will be generally firm, while in black leg it is always rotted. If the lower part of the stalk be cut across, or if the thick outer skin is peeled away, there will be found

streaks of brown tissue running up inside the stem, which are absent from healthy plants. The same brown streaks will be found in the flesh of some of the tubers

Fig. 157.—Browning in Stem End of Tuber Due to Wilt.

near the stem end. When this is found one is dealing with a case of wilt.

The cause of the disease is a parasitic mould which grows in the water-conducting channels of the stem and chokes them, shutting off the water supply to the leaves. The plant often dies as a result. The fungus also grows into a majority of the tubers through the same channels and produces the same kind of brown marks in them as in the stem. There is evidence to show that in certain years the parasite may be growing in the stem and may infect the tubers without producing visible signs of wilting. The conditions which cause this to happen are not clear. The fungus is carried mainly by the use of tubers for seed which have the brown marking above described in the stem end. The control of the disease consists of selecting seed from healthy plants and carefully discarding in their entirety any tubers which show traces of browning in the flesh when the seed is being cut. Disinfection of the seed is of no avail.

418. Leaf Roll.—This is possibly the most serious disease of potatoes in Canada, but it is only found in small

quantities as a rule in the Western Provinces. The plants which are attacked by it have a peculiar habit of growth, being somewhat dwarfed and upright, and are generally of a somewhat light green color. The rolling of the leaves is not at all conspicuous but the lowest leaves of the plant are rolled up instead of being normally flat and will invariably be found to be leathery to the touch. These leaves often have brown spots on them and they ultimately begin to die from the tips backwards. The tubers are normal in appearance but they are generally formed quite close to the main stem. The set usually remains sound.

Fig. 158.—Potato Plant Affected With Wilt.

The cause of leaf roll is unknown. The constitution of the plant is radically affected by the disease, for the crop is reduced to about one-third of the normal, and the proportion of unmarketable potatoes is high, being about 50 per cent. of the total on the average. The predisposing cause is known to be unfavorable climatic conditions. Thus when healthy seed is imported to certain portions of southern Ontario it grows well for one year, but develops increasing amounts of leaf roll each succeeding year until the whole crop is affected. The leaf roll dis-

ease is found in such small and scattered amounts in the Prairie Provinces that it is probably to be traced to an initial use of affected seed. Its appearance in some of the truck farms around Winnipeg, where some crops from 70 to over 90 per cent. diseased, were found, is known to be due in some cases to the planting of early potatoes imported for table purposes from the Southern States.

The infection is always carried in the seed and it is not believed that the soil becomes infected. It has been proven recently that the disease may spread to a certain extent from plant to plant in the field, but it does not make its appearance until the year after the infection takes place.

The control consists of the avoidance of the use of tubers for seed from diseased plants. If a crop contains only a comparatively small number of leaf roll plants it may be eradicated by selecting seed from the healthy hills, while if the diseased plants are numerous it will be found quicker and more satisfactory to purchase

Fig. 159.—Leaf Roll.

Showing (A) leaf roll plant of bushy type and pronounced rolling of lower leaves. (Early Ohio). (B) Leaf roll plant of upright habit showing rolling of lower leaves (Empire State). (C) Leaf roll plant of early Puritan variety.

seed from a healthy crop. If the disease reappears afterwards it may be necessary to obtain healthy seed

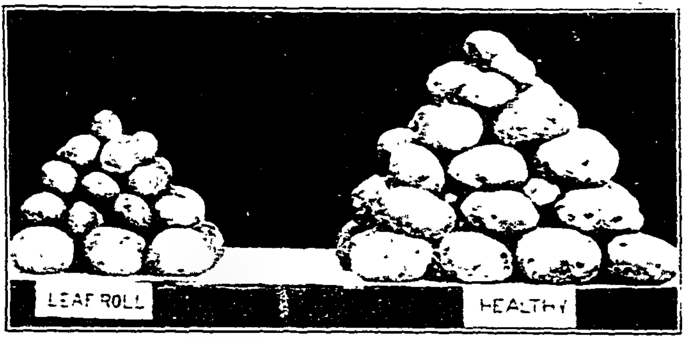

Fig. 160.—How Leaf Roll Affects Yields.
Showing comparative yields of leaf roll and healthy plants. Average of three years' experiments.

periodically. It is impossible to recognize diseased potatoes after they are dug and treatment of the seed is useless.

419. Mosaic.—Mosaic is another very harmful disease, particularly in the East. Plants attacked by it are easily

Fig. 161.—A Mosaic and Healthy Plant. (Early Rose.)

recognized owing to the leaves being more corrugated than normal and mottled with faint green spots. This gives them a patterned or mosaic-like appearance. In

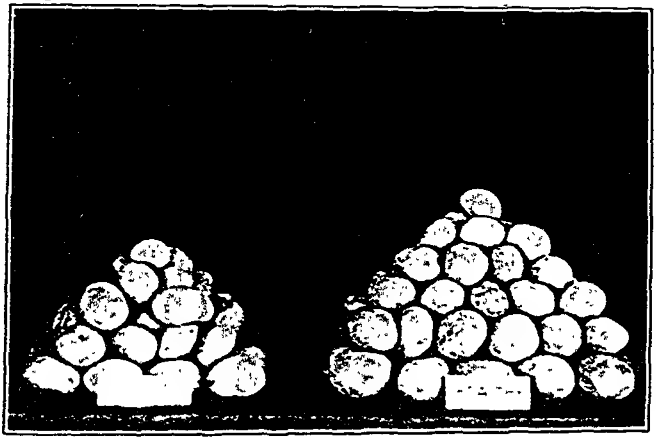

Fig. 162.—How Mosaic Affects Potato Yields.
Comparative yields of mosaic and healthy plants. Average of three years' experiments

severe attacks the size and spread of the leaves are reduced and the plant is somewhat dwarfed. The lower leaves tend to drop off and the stalks may lie prostrate in later stages. Mosaic plants are very subject to tip burn. Certain varieties are usually susceptible to the disease, among which seems to be Hamilton's Early, a popular early variety in the West.

Mosaic is very similar to leaf roll in its cause and affects. It is apparently not parasitic in origin. The yield is reduced to about two-thirds of the normal and there is a somewhat larger percentage of unmarketable potatoes than usual. Tubers from diseased hills invariably carry the infection. There is also ground for

believing that the infection may be spread from plant to plant in the field. The method of control given for leaf roll is applicable to mosiac also.

420. Curly Dwarf.—This is another similar but rare disease. The plant is very much dwarfed and the leaves are huddled up together very close to the main stem. The foliage is of a normal or somewhat dark green color. Death takes place prematurely and the yield is reduced almost to nothing. The infection is carried in the seed and the control measures to be adopted are the same as those given for leaf roll.

Fig. 163.—How Curly Dwarf Affects Growth.
A healthy and curly dwarf plant. (Irish Cobbler.)

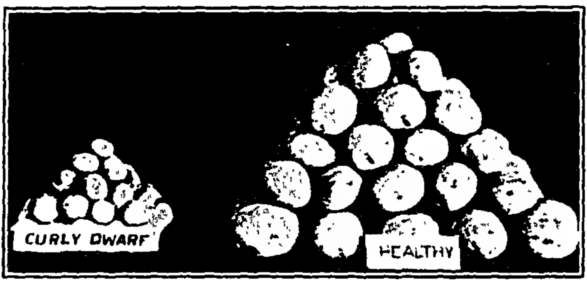

Fig. 164.—How Curly Dwarf Affects Yields.
Comparative yields of curly dwarf and healthy plants. Average of three years' experiments

APPENDIX

FIG. 165.—*Table showing estimated acreage of cultivated land and food production of the principal countries in pre-war period.**

Country	Estimated acreage of cultivated land	Population	Acreage of cultivated land per capita	Estimated average production, 1911-1913, of important food crops expressed in— Tons	Calories (in millions) Total	Per capita
United States	318,526,000	91,972,000	3.5	133,411,308	425,442,000	4.63
Russian Empire	278,615,000	163,779,000	1.7	121,600,344	300,511,000	1.83
India (British)	264,858,000	244,268,000	1.1	59,637,968	198,133,000	0.81
German Empire	65,445,000	67,812,000	1.0	84,331,901	143,440,000	2.12
Austria-Hungary	61,450,000	49,458,000	1.2	46,458,352	103,241,000	2.09
France	59,124,000	39,602,000	1.5	90,650,476	70,829,000	1.79
Argentina	44,446,000	7,092,000	6.3	14,479,614	45,767,000	6.45
Italy	33,815,000	34,687,000	1.0	11,959,546	31,834,000	1.00
Canada	37,063,000	8,075,000	4.6	17,107,305	50,835,000	6.30
United Kingdom	17,862,000	45,366,000	0.4	14,040,491	25,730,000	0.56
Japan	17,639,000	51,646,000	0.3	11,924,729	37,351,000	0.72
Australia	11,987,000	4,455,000	3.4	3,956,776	11,991,000	2.69

*From "Geography of the World's Agriculture."

FIG. 166.—*Table showing production of principal crops in the world and in principal countries, average for 1911-13.*‡

Country	Corn (bushels)	Wheat (bushels)	Oats (bushels)	Rye (bushels)
United States	2,701,074,000	704,995,000	1,154,131,300	36,721,300
Russian Empire	78,110,000	727,133,300	1,050,574,700	935,010,300
India (British)	87,526,700	369,612,300	....	....
German Empire		160,236,700	595,660,700	455,181,700
France	20,557,000	324,136,700	300,380,300	48,078,700
Austria-Hungary	210,855,300	247,141,000	245,937,700	163,640,000
Italy	100,245,300	190,840,000	37,582,700	5,390,300
United Kingdom		61,297,300	179,359,000	1,666,700
Argentina*	251,875,300	155,828,300	65,311,000	1,748,300
Canada	17,636,000	228,933,300	387,150,000	2,406,700
Australia	10,432,000	88,961,000	14,131,000	95,700
Japan	3,637,000	26,305,300	....	....
Other countries	408,426,000	527,589,700	336,493,700	131,454,700
Total	3,950,374,000	3,813,009,900	4,375,727,100	1,781,394,400

Country	Barley (bushels)	Potatoes (bushels)	Rice (bushels = 60 lbs. clean rice)	Sugar (long tons)
United States	187,417,700	348,303,000	11,808,700	1,639,000
Russian Empire	484,848,000	1,287,880,700	6,151,900	1,630,700
India (British)	38,097,700	....	1,087,002,300	2,407,000
German Empire	157,921,700	1,698,826,000	....	2,227,000
France	47,608,700	506,884,700	39,100	643,000
Austria-Hungary	153,437,000	642,149,000	....	1,496,700
Italy	10,029,300	61,410,300	11,052,600	186,300
United Kingdom	62,528,300	259,482,700	....	....
Argentina*	5,096,700	38,029,000	410,300	242,900
Canada	47,370,700	78,222,300	....	....
Australia	2,816,700	13,842,700	....	253,700
Japan	92,834,700	25,508,700	265,588,200	65,000
Other countries	233,954,700	516,735,000	†1,551,132,600	6,015,000
Total	1,523,961,900	5,477,274,100	2,933,185,700	16,806,300

*Average for 1912-1914.
†Including incomplete estimates for China.
‡From "Geography of the World's Agriculture."

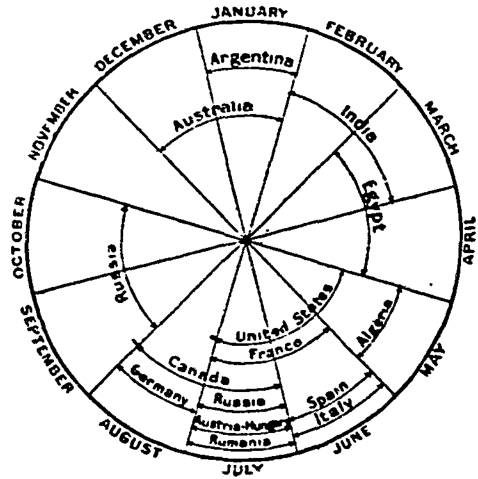

Fig 167.—Chart Showing Time of the World's Wheat Harvests

FIG. 168 *Table Showing Total Areas and Values of Field Crops in Canada, 1911-1916.**

AREAS.

Provinces.	1911.	1912.	1913.	1914.	1915.	1916.
	acres.	acres.	acres.	acres.	acres.	acres.
Canada	31,515,672	35,575,550	35,371,030	33,436,675	39,140,460	38,930,333
P. E. Island	477,635	462,880	456,970	461,510	481,030	485,010
Nova Scotia	709,703	700,160	711,630	693,860	727,260	716,580
New Brunswick	978,530	931,990	906,130	901,055	893,800	889,220
Quebec	5,375,066	5,010,400	4,808,800	4,863,850	4,901,760	4,590,200
Ontario	9,618,999	9,319,000	9,200,000	8,973,700	9,391,500	7,037,500
Manitoba	5,131,087	4,971,100	4,965,000	4,671,700	4,843,810	5,030,000
Saskatchewan	8,641,102	10,315,800	10,397,600	9,238,000	13,030,590	13,850,769
Alberta	3,351,715	3,603,060	3,690,100	3,369,270	4,570,948	5,100,511
British Columbia	226,105	230,860	238,700	260,640	292,880	289,650

VALUES

Provinces.	1911.	1912.	1913.	1914.	1915.	1916.
	$	$	$	$	$	$
Canada	397,926,000	557,344,100	552,771,500	638,580,300	825,370,600	886,494,900
P. E. Island	9,699,300	9,456,000	9,535,500	11,511,000	10,930,100	11,121,400
Nova Scotia	17,171,500	19,420,000	17,132,000	21,069,700	19,550,700	22,369,800
New Brunswick	17,695,200	17,295,700	17,065,100	20,045,100	20,402,600	22,921,200
Quebec	106,218,000	69,901,000	88,589,000	99,270,000	101,683,000	102,937,300
Ontario	195,764,000	198,715,000	167,835,000	190,220,000	207,043,500	190,646,000
Manitoba	76,518,000	71,647,000	64,557,000	65,628,400	92,318,800	76,749,000
Saskatchewan	115,426,000	115,813,000	129,376,000	152,751,500	205,605,700	292,773,000
Alberta	48,475,000	44,703,400	46,712,000	59,779,600	93,511,200	148,738,600
British Columbia	11,406,000	10,593,000	11,069,000	11,463,000	11,625,700	15,232,000

*From Canada Year Book, 1916-17.

FIG. 169—*Statement Showing the estimated average yield per acre of the various grains grown in the Provinces of Manitoba, Saskatchewan and Alberta, for the years 1898 to 1915.—From 1915 Report Department of Trade and Commerce.*

Years.	Manitoba.	YIELD PER ACRE—WHEAT.			YIELD PER ACRE—OATS.			YIELD PER ACRE—BARLEY.			YIELD PER ACRE—FLAX.		
		Saskatchewan	Alberta		Manitoba	Saskatchewan	Alberta	Manitoba	Saskatchewan	Alberta	Manitoba	Saskatchewan	Alberta
			Spring	Winter									
1898	17.41	17.30	25.27	......	35.02	23.95	11.50	29.17	21.81	32.00	11.00	. .	. .
1899	17.13	18.49	23.17	. . .	38.30	30.17	12.16	29.10	20.97	26.80	11.00	.	. .
1900	8.90	9.00	19.22		20.50	17.68	33.82	18.90	18.10	25.37	8.10	. . . .	. .
1901	25.10	25.41	24.58		40.20	44.76	40.68	34.20	31.48	32.81	12.00	. . .	
1902	26.00	22.57	18.86		47.50	30.93	31.71	35.90	20.91	21.31	12.70	9.80	12.00
1903	16.42	19.44	18.65	23.95	38.62	32.71	31.05	26.66	24.94	25.61	10.50	9.20	9.31
1904	16.52	17.51	16.58	18.33	38.80	31.04	31.01	30.51	24.27	26.12	13.10	10.15	13.63
1905	21.07	23.09	21.46	21.11	42.60	42.70	39.18	32.50	27.44	27.36	13.20	15.73	11.34
1906	19.49	21.40	23.07	21.11	45.85	37.45	39.12	26.96	24.57	20.32	14.60	9.35	10.65
1907	14.22	13.52	18.25	20.66	34.80	29.09	30.11	25.70	17.02	19.78	12.25	10.62	7.87
1908	17.28	13.68	18.81	29.47	36.80	27.20	36.93	27.54	17.28	25.03	11.80	9.78	7.96
1909	17.33	22.10	25.00	25.00	37.10	17.10	40.00	27.31	32.10	25.00	12.20	13.00	*0.81
1910	13.47	15.58	12.61	15.48	28.70	30.40	24.61	20.75	21.58	20.78	9.97	7.08	8.02
1911	18.29	18.50	20.75	23.74	45.30	45.00	11.21	31.50	28.00	20.41	11.00	11.13	9.30
1912	22.20	19.18	21.54	21.83	42.10	45.99	40.30	32.02	32.87	33.05	12.10	12.01	12.83
1913	19.02	21.25	23.00	21.00	40.60	41.12	43.65	28.81	31.30	32.15	11.70	11.21	11.00
1914	14.81	13.71	21.30	21.00	28.25	21.53	38.00	21.00	16.90	27.00	8.11	6.40	7.67
1915	28.81	28.51	32.67	33.92	48.21	53.67	56.35	30.25	36.83	37.75	11.00	13.00	16.05

*Probably an error, reported 10.51 in Provincial Statement.

FIG. 170.—*Table showing percentage of different grades of wheat as per Western Grain Inspection**

NAME	Crop, 1896	Crop, 1897	Crop, 1898	Crop, 1899	Crop, 1900	Crop, 1901	Crop, 1902	Crop, 1903	Crop, 1904	Crop, 1905	Crop, 1906	Crop, 1907	Crop, 1908	Crop, 1909	Crop, 1910	Crop, 1911	Crop, 1912	Crop, 1913	Crop, 1914
No. 1 Hard	57	65	31½	70	8	45	38	2	½	1	6	¼	¼	..	..	..	¼	½	..
No. 2 Hard	20	24	6½	13	15	1	..	.		.	..	..	.		.	....	..	..	...
No. 3 Hard	8	2		5½	30	....													
No. 1 Northern	5	3½	28	3½	2	35	30	18	10	55	41	12½	17½	37½	16	21	10½	55½	16½
No. 2 and 3 Northern			2	¼		10	25	58	55	25½	30	36½	49½	50½	60	37½	57½	33½	58½
Nos. 1 and 2 Spring	½	¼	2½																
Rej. and No Grade	4	5	25½	6½	45	7	1	7	14½	17½	14	9½	12	7	5½	15	23	8½	8
Other Grades	5½	¼	4½	1¼		3	6	15	20	½	8	38½	16½	3½	17	12	7½	2	16½
Winter Wheat	.	.	..	....	...	...	.	.			1	3	4½	1½	1½	2½	1½	¼	
	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

*From Seventeenth Annual Report, Winnipeg Grain Exchange.
†Abolished 1901.

FIG. 171.—*Table showing percentage of different grades of oats, barley, flax and rye as per Western grain inspection (for the seven years ending 1915).*

OATS

Extra No. 1 Oats	.84%
No. 1 C. W.	1.87%
No. 2 C. W.	15.74%
No. 3 C. W.	11.95%
No. 2 White	.05%
No. 2 Mixed	.60%
No. 3 Mixed	.84%
No. 1 Black	.07%
No. 2 Black	.84%
Feed Extra No. 1	14.56%
Feed No. 1	9.11%
Feed No. 2	5.67%
Rejected	2.50%
No Grade	7.20%
Condemned	.34%
Mixed Grain	.55%

BARLEY

No. 2 Barley	0.22%
No. 3 Extra	2.57%
No. 3	52.03%
No. 4	28.85%
Rejected	8.09%
No. Grade	5.07%
Feed	3.46%
Condemned	.07%
Cleanings	.79%

FLAX

No. 1 N. W. Manitoba Flax	75.43%
No. 1 Manitoba	14.87%
No. 2 C. W.	8.55%
No. 3 C. W.	2.19%
Rejected	7.13%
No Grade	1.92%
Condemned	1.37%

RYE

No. 1 C. W. Rye	33.26%
No. 2 C. W.	51.38%
No. 3	.....
No Grade	12.16%
Rejected	3.20%

FIG. 172.—*Table showing relative prices of Wheat, Oats, Barley, Rye, Flax and Potatoes at Chicago.*

Year	Wheat		Oats		Barley		Rye		Flax Duluth		Potatoes	
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
1895.....	51½	82⅜	16 62	30.88	33 00	56 50	32 00	70 00	....	....	.17	.75
1896.....	54	80⅞	14 75	20.25	20 00	40 00	28 00	43 00	.....	....	.10	.31
1897.....	65	107	15.62	23 88	22.00	47.00	31 75	56 00	71	1.21	18	.92
1898.....	62¼	178	20.25	32.00	26 50	53 00	44 00	75 00	97	1 35	20	.87
1899.....	64	77½	19 25	28 25	34 00	54 00	49 00	62 00	90	1 42	26	.75
1900.....	62⅝	78	21 00	26 25	33.00	62 00	44.50	60 50	1 20	1 87	25	.50
1901.....	67⅝	73¾	23 25	48.25	38 00	65 00	46 75	65.75	1 31	1 88	.30	1.25
1902.....	67½	95	25 00	56 00	35 00	73 00	48 00	67 50	1 15	1 78	30	1.00
1903.....	70¼	93	31.25	45.00	42 00	63 00	48 00	60 00	.92	1 20	38	.85
1904.....	81¼	122	28 25	46 00	35 00	61 00	51 00	81.00	1 02	1 28	31	1.22
1905.....	82½	124	25.00	31 25	36 50	55 00	57 50	84.00	96	1 50	18	.72
1906.....	71	87¼	22.88	42.75	38 00	58 00	55 50	68 00	1 09	1 26	40	.87
1907.....	79	122	33 50	56 50	45 00	110 00	60 00	91.25	1 07	1 42	30	.75
1908.....	102	124	46.00	60 50	49 00	106 00	72 00	87.00	1 13	1 40	50	1.50
1909.....	103	140	36.50	62 50	50 00	82 50	67 00	91.00	1 37	2 05	.15	1.60
1910.....	100	120½	29.75	49.00	50 00	90 00	72 00	82 00	1 80	2 81	10	.98
1911.....	93	117	28.88	47.62	70 00	139 00	80 00	113 00	1.93	2 70	30	2.25
1912.....	85	122	30.25	58 50	40 00	110 00	58 00	96 50	1 22	2.53	.32	2.00
1913.....	85	96	31.62	43.38	42 00	85 00	58 00	70 50	1 23	1.53	.15	.82
1914.....	88½	133	30 50	51 12	49 00	82 00	55 00	112 50	1 29	1 93	.28	1.76
1915.....	99	167	35.50	60.12	51 00	91 00	91.00	131 00	1 63	2 21	17	1.50

FIG. 173.—*Winnipeg cash price of No. 1 Northern Wheat in store Fort William on first market day of each month.—1914 Report Saskatchewan Department of Agriculture.*

Month	1906	1907	1908	1909	1910	1911	1912	1913	1914
January	$0.75	$0.71	$1.07	$0.99	$1.03	$0.92	$0.93	$0.81	$0.83
February	0.76	0.73	1.05	1.00	1.02	0.92	.96	0.83	0.86
March	0.71	0.74	1.09	1.11	1.03	0.88	0.98	0.85	0.91
April	0.75	0.75	1.06	1.13	1.05	0.88	1.00	0.87	0.89
May	0.78	0.80	1.10	1.20	1.00	0.91	1.03	0.92	0.90
June	0.79	0.90	1.10	1.26	1.00	0.95	1.03	0.93	0.91
July	0.81	0.92	1.02	1.32	1.00	0.97	1.08	0.96	0.89
August	0.78	0.91	1.01	1.10	1.06	0.96	1.06	0.95	0.97
September	0.71	0.97	0.97	0.95	0.99	1.00	1.05	0.88	1.13
October	0.75	1.03	0.97	0.96	0.98	1.00	0.88	0.82	1.07
November	0.71	1.03	0.98	0.98	0.89	0.98	0.87	0.81	1.17
December	0.72	1.02	0.99	0.96	0.90	0.96	0.78	0.83	1.17
Average	.761	.881	1.039	1.085	1.001	.948	.973	.876	.982

FIG. 174.—*Statement showing the average price per bushel per year at Winnipeg for different grades of grains during the years, 1906 to 1915 inclusive.*

Grade	1915	1914	1913	1912	1911	1910	1909	1908	1907	1906
Wheat—No. 1 Northern	$127 76	$100 18	$87 99	$98 28	$95 46	$99 15	$100 90	$101 60	$89 76	$76 00
No. 2 Northern	125 66	97 90	85 54	95 22	92 05	96 98	107 77	101 90	87 42	71 79
No. 3 Northern	[illegible]3 40	95 03	82 42	91 44	89 70	93 98	105 43	97 80	83 30	72 58
No. 4 Northern	[illegible] 55	91 03	77 25	84 26	84 43	90 42	101 40	90 33	79 26	
No. 5 Northern	[illegible]2 78	86 00	72 05	73 45	77 73	86 14	93 29	84 17		
No. 6 Northern	[illegible]0 44	80 39	66 88	64 92	74 49	78 64	86 83	73 02		
No. 1 Rejected	[illegible]5 22	95 05	81 49	86 48	90 61	93 87	99 36			
No. 2 Rejected	[illegible]02 94	92 80	79 28	85 05	89 63	91 78	96 96			
No. 1 Smutty	[illegible]8 09	94 95								
No. 2 Smutty	[illegible]5 07	92 70								
Feed	106 37	75 19	77 43	56 61	61 39	64 33	76 89	62 72	52 40	
Oats—No. 2 C.W.	53 06	42 65	33 75	41 44	36 42	34 22	40 75	42 93	44 03	
No. 3 C.W.	50 88	41 27	31 73	37 09	35 42	32 65	39 89	40 42	39 16	
Ex. 1 Feed	50 75	41 26								
No. 1 Feed	49 58	40 62								
No. 2 Feed	48 45	39 98								
Barley—No. 3 C.W.	67 65	51 51	46 45	57 08	61 86	46 00	50 30	49 82	50 40	
No. 4 C.W.	62 86	51 72	44 21	52 04	52 00	44 45	48 28	48 22	48 76	
Flax—No. 1 N.W.	162 81	132 55	116 78	161 61	218 09	223 02	111 95	115 27	122 58	
No. 2 C.W.	159 70	129 48	114 15	161 33	215 87	220 48	110 29	113 40	111 01	

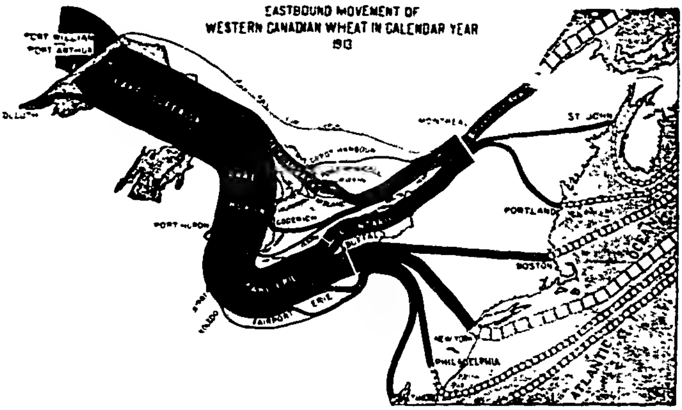

Fig 175 - Diagram Illustrating the "Grain Spout" of Western Canada.

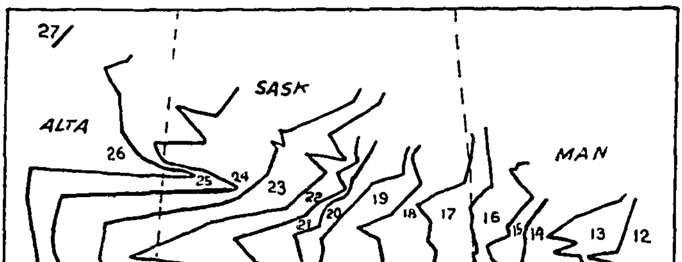

Fig. 176.—Freight Rates on Wheat from Points in Western Canada to Head of the Lakes in Cents per Hundred Pounds. From Pre-war Freight Schedules.

FIG. 177.—*Average freight rates from head of Lakes to Montreal.**

1909	4 2-3c.
1910	4 1-4c.
1911	5 1-10c.
1912	5 4-5c.

FIG. 178. *Ocean freight rates on wheat from ports named to United Kingdom. (Cents per bushel. Average for six years ending 1914).**

	New York	Odessa	Karachi	River Plate Down River	Sailer Australia
1909...	3.185	4.310	9.187	6.105	14.428
1910...	3.917	5.786	10.854	5.658	15.815
1911...	3.288	5.180	10.239	5.001	14.152
1912...	7.593	7.809	11.761	13.528	19.033
1913...	5.611	7.142	12.177	10.327	20.717
1914...	8.757	4.501	9.721	10.512	14.350
Average	5.447	5.797	11.206	8.526	16.120

FIG. 179—*Average ocean freight rates by months on heavy grain between Montreal and Liverpool—1909 to 1914.**

	1909	1910	1911	1912	1913	1914
May......	4.750	3.375	3.937	6.000	8.625	4.312
June.......	3.375	3.438	3.937	6.750	8.250	5.250
July........	2.625	2.937	3.937	6.375	8.625	6.000
August.....	3.562	2.437	4.500	6.375	7.125	6.000
September..	5.250	3.187	5.250	6.187	6.750	7.312
October....	5.250	4.500	5.156	10.125	7.125	7.875
November..	5.625	4.312	5.437	10.125	7.500	11.812
Total.	25.737	24.186	32.154	51.937	54.000	48.561
Average....	3.677	3.455	4.593	7.419	7.728	6.936

*From Georgian Bay Canal Commissions Report.

FIG. 180A.—*Yearly average prices of wheat in England, 1641-1770.*

Year	Per bushel	Year	Per bushel	Year	Per bushel	Year	Per bushel
	$ c		$ c		$ c		$ c
1641....	1.74	1674....	1.86	1707....	0.77	1739....	1.04
1642....	1.83	1675....	1.75	1708....	1.12	1740....	1.37
1643....	1.82	1676....	1.03	1709....	2.12	1741....	1.26
1644....	1.86	1677....	1.14	1710....	2.11	1742....	0.92
1645....	1.56	1678....	1.59	1711....	1.46	1743....	0.67
1646....	1.30	1679....	1.62	1712....	1.25	1744....	0.67
1647....	1.99	1680....	1.22	1713....	1.38	1745....	0.74
1648....	2.30	1681....	1.26	1714....	1.36	1746....	1.05
1649....	2.16	1682....	1.19	1715....	1.16	1747....	0.94
1650....	2.07	1683....	1.08	1716....	1.30	1748....	1.00
1651...	1.98	1684....	1.19	1717....	1.23	1749....	1.00
1652....	1.34	1685....	1.26	1718....	1.05	1750....	0.88
1653....	0.96	1686....	0.92	1719....	0.94	1751....	1.04
1654....	0.70	1687....	0.68	1720....	1.00	1752....	1.13
1655....	0.90	1688....	1.24	1721....	1.01	1753....	1.21
1656....	1.16	1689....	0.81	1722....	0.97	1754....	0.94
1657....	1.26	1690....	0.94	1723....	0.94	1755....	0.92
1658....	1.76	1691....	0.92	1724...	1.00	1756....	1.22
1659....	1.78	1692....	1.26	1725....	1.31	1757....	1.62
1660....	1.52	1693....	1.83	1726...	1.24	1758....	1.35
1661....	1.89	1694....	1.73	1727....	1.14	1759....	1.07
1662....	2.00	1695....	1.43	1728...	1.47	1760....	0.99
1663...	1.54	1696....	1.92	1729 ...	1.26	1761....	0.81
1664....	1.09	1697....	1.62	1730....	0.99	1762....	1.05
1665....	1.33	1698....	1.85	1731....	0.89	1763....	1.10
1666....	0.97	1699....	1.73	1732...	0.72	1764...	1.26
1667....	0.97	1700....	1.09	1733....	0.77	1765....	1.46
1668....	1.08	1701....	1.02	1734....	0.94	1766....	1.31
1669....	1.20	1702....	0.80	1735....	1.16	1767....	1.44
1670....	1.13	1703....	0.97	1736 ..	1.09	1768...	1.63
1671....	1.14	1704....	1.26	1737....	1.03	1769...	1.23
1672....	1.11	1705....	0.81	1738 ...	0.96	1770....	1.32
1673....	1.26	1706....	0.70				

FIG. 180B.—*Yearly average prices of wheat, barley and oats in England and Wales, 1771-1915.*

Year	Wheat per bushel	Barley per bushel of 50 lbs.	Oats per bushel of 39 lbs.	Year	Wheat per bushel	Barley per bushel of 50 lbs.	Oats per bushel of 39 lbs.
	$ c	$ c	$ c		$ c	$ c	$ c
1771	1 48	0 80	0 52	1821	1 71	0 79	0 60
1772	1 50	0 79	0 51	1822	1 36	0 66	0 55
1773	1 60	0 87	0 53	1823	1 62	0 96	0.70
1774	1 65	0 89	0 56	1824	1 94	1 11	0 76
1775	1 52	0 81	0 52	1825	2 08	1 22	0 78
1776	1 20	0 63	0 47	1826	1 78	1 04	0 81
1777.	1 43	0 64	0 49	1827	1 78	1 14	0 86
1778	1 32	0 70	0 47	1828	1 84	1 00	0 68
1779..	1 05	0 61	0 44	1829.	2 02	0 90	0 69
1780.	1 12	0 73	0 40	1830	1 95	0 90	0.75
1781	1 40	0 74	0 43	1831	2 02	1 16	0 77
1782.	1 50	0 70	0 47	1832	1 78	1 01	0 62
1783	1 65	0 95	0 62	1833	1 61	0 84	0 56
1784	1 54	0 87	0 57	1834	1 40	0 88	0 64
1785	1 31	0 75	0 54	1835	1 20	0 91	0 67
1786	1 22	0 76	0 56	1836	1 48	1 00	0 70
1787	1 29	0 71	0 52	1837	1 70	0 92	0 70
1788 .	1 41	0 69	0 49	1838	1 96	0 96	0 68
1789	1 60	0 71	0 50	1839	2 15	1 20	0 79
1790	1 67	0 77	0 59	1840	2 02	1 11	0 78
1791	1 48	0 82	0 55	1841	1 95	1.00	0.68
1792	1 31	0 84	0 51	1842	1 74	0 83	0 58
1793	1 50	0 95	0 62	1843	1 52	0 91	0 56
1794 .	1 59	0 97	0 65	1844	1 56	1 02	0 62
1795	2 29	1 13	0 71	1845	1 55	0 96	0 68
1796..	2 39	1 07	0 66	1846	1 66	0 98	0 72
1797 .	1 63	0 82	0 49	1847	2 12	1 31	0 87
1798	1 58	0 88	0 59	1848	1 54	0 95	0 62
1799	2 10	1 10	0 67	1849	1 35	0 84	0 53
1800	3 46	1 82	1 19	1850	1 22	0 70	0.50
1801.	3 63	2 08	1 13	1851	1 17	0 74	0 57
1802.	2 12	1 01	0 62	1852	1 24	0 87	0.58
1803	1 79	0 77	0 65	1853	1 62	1 02	0 64
1804	1 89	0 94	0 74	1854	2 20	1 09	0 85
1805	2 73	1 37	0 86	1855	2 27	1 06	0 83
1806	41	1 18	0 84	1856	2 10	1 24	0 77
1807	2 29	1 20	0 86	1857	1 71	1 28	0 76
1808	2 46	1 32	1 01	1858	1 34	1 05	0.75
1809	2 96	1 42	0 96	1859	1 33	1 02	0.70
1810 .	3 24	1 46	0 87	1860	1 62	1 11	0 74
1811	2 90	1 28	0 84	1861	1 68	1 10	0 72
1812	3 85	2 03	1 45	1862	1 69	1 07	0 69
1813	3 34	1 78	1 17	1863	1 36	1 03	0 64
1814 .	2.26	1 14	0 78	1864	1 22	0 91	0 61
1815.	1 99	0 92	0.72	1865	1 27	0 90	0 66
1816 .	2 39	1 03	0 83	1866	1 51	1 13	0 75
1817 .	2 95	1 50	0 99	1867	1 96	1 22	0 79
1818	2 62	1 64	0 99	1868	1 94	1 31	0 85
1819 ...	2 27	1 39	0 86	1869	1 47	1 20	0 79
1820 . .	2 06	1 03	0 73	1870	1 43	1 05	0 69

Fig 180B.—Continued.

Year	Wheat per bushel	Barley per bushel of 50 lbs.	Oats per bushel of 39 lbs.	Year	Wheat per bushel	Barley per bushel of 50 lbs.	Oats per bushel of 39 lbs.
	$ c	$ c	$ c		$ c	$ c	$ c
1871	1 72	1 10	0 77	1894....	0 69	0 75	0.52
1872......	1 73	1 14	0 70	1895. ...	0 70	0.67	0.44
1873.. . .	1 78	1 23	0 77	1896 ..	0.80	0 70	0.45
1874 ...	1.70	1 37	0 88	1897 .	0 92	0.71	0.51
1875	1 37	1 17	0 87	1898 .	1 03	0 82	0 56
1876	1.40	1 07	0 80	1899.	0.78	0 79	0.52
1877.....	1 73	1.21	0.79	1900..	0 82	0 76	0.54
1878......	1 41	1 22	0 74	1901. .	0.81	0.77	0.56
1879......	1 33	1.04	0.66	1902 . .	0 85	0.78	0.61
1880.....	1 35	1 01	0 70	1903 .	0 81	0 69	0.52
1881......	1 38	0 97	0 66	1904 . .	0.86	0.68	0.50
1882	1 37	0 95	0 66	1905...	0.90	0 74	0.53
1883......	1.26	0.97	0 65	1906...	0.86	0 73	0.56
1884......	1 08	0.93	0 62	1907..	0 93	0.76	0.57
1885......	1.00	0 92	0.63	1908	0.97	0 79	0.54
1886......	0 94	0 81	0.58	1909....	0 82	0.82	0.58
1887.....	0.99	0.77	0 49	1910	0.96	0.70	0.53
1888......	0 97	0 85	0 51	1911	0 96	0.83	0.57
1889......	0.90	0 79	0.54	1912.....	1.06	0 93	0.65
1890......	0 97	0 87	0 57	1913	0.96	0.83	0.58
1891......	1.13	0 86	0 61	1914.....	1.06	0.83	0.64
1892	0 92	0 80	0.60	1915. ...	1 61	1.13	0.92
1893	0 80	0.78	0 57				

FIG. 181.—*A comparison of the food produced annually by an acre of land when utilized in the production of various food crops and live-stock products.**

Food products	Yield per acre: Bushels	Yield per acre: Pounds	Calories per pound	Pounds protein per acre (digestible)	Calories per acre
FOOD CROPS;					
Corn . . .	35	1,960	1,594	147.0	3,124,240
Potatoes.	100	6,000	318	66.0	1,908,000
Rye.	20	1,200	1,506	118.8	1,807,200
Wheat.	20	1,200	1,490	110.4	1,788,000
Rice, polished . .	. . . . . .	1,086	1,456	50.0	1,581,216
Soy beans.	16	960	1,598	294.7	1,534,000
Peanuts	34	524	2,416	126.2	1,265,018
Oats . .	35	*b* 784	1,600	89.4	1,254,400
Beans . . .	14	840	1,337	157.9	1,123,080
Cowpeas.	10	600	1,421	116.4	852,600
Buckwheat.	24	*c* 600	1,252	34.5	751,800
DAIRY PRODUCTS,					
Milk . . .	. . . . . .	2,190	325	72.3	711,750
Cheese	. .	219	1,950	56.7	427,050
Butterfat. .	. . . . . .	98.55	3,605	1.0	355,273
	Live (pounds)	Dressed (pounds)			
MEAT;					
Pork	350	273	2,465	22.7	672,945
Mutton. . .	205	113	1,215	14.7	137,295
Beef.	216	125	1,040	18.5	130,000
POULTRY; *d*					
Meat.	103	66	1,045	12.7	68,970
	Dozen	Pounds			
Eggs	73.8	110.7	720	14.8	79,704
Total	. .		. . .	27.5	148,674
	Live (pounds)	Dressed (pounds)			
For poultry meat alone	267	171	1,045	33.0	178,695
	Dozen	Pounds			
For eggs alone.	122.4	183.6	720	24.6	132,192

b Hulled kernels.

c Flour.

d The first section under "poultry" assumes that poultry are kept under ordinary poultry-farm conditions, the pullets being raised and the old hens and young males being used for meat. What eggs are not needed for hatching purposes are used for food.

The data for "poultry meat alone" assume the purchase of day-old chicks, which are grown to a 4-pound weight and utilized as food.

The data for "eggs alone" assume the purchase of hens and their utilization for the production of eggs alone.

* From Bulletin No. 877 United States Department of Agriculture.

FIG. 182.—*Approximate number of seeds per pound of the ordinary farm crops.*

Wheat	12,000	to	20,000
Emmer (with hull)	8,000	to	12,000
Speltz (with hull)	4,000	to	6,000
Oats	12,000	to	22,000
Six Rowed Barley	14,000	to	18,000
Two Rowed Barley	12,000	to	16,000
Hulless Barley	10,000	to	15,000
Rye	18,000	to	24,000
Flax (small seeded)	100,000	to	125,000
Golden Flax	50,000	to	80,000
Peas (small)	3,000	to	4,000
Peas (medium size)	2,000	to	3,000
Peas (large size)	1,500	to	2,000
Swede Turnips	110,000	to	150,000
Rape	90,000	to	100,000
Mangels	35,000	to	45,000
Carrots	350,000	to	100,000
Corn	1,200	to	2,400
Western Rye Grass	150,000	to	180,000
Brome Grass	130,000	to	150,000
Timothy	1,000,000	to	1,500,000
Kentucky Blue Grass	1,400,000	to	2,000,000
Red Top	4,000,000	to	4,250,000
Meadow Fescue	230,000	to	260,000
Alsike Clover	650,000	to	750,000
Red Clover	200,000	to	300,000
White Clover	700,000	to	800,000
Alfalfa	200,000	to	250,000
Millet (Foxtail)	200,000	to	250,000

FIG. 183.—*Weight of seeds per bushel.*

CEREALS—	
Wheat	60 lbs.
Oats	34 lbs.
Barley	48 lbs.
Rye	56 lbs.
Corn	56 lbs.
Flax	56 lbs.
Peas	60 lbs.
Potatoes	60 lbs.
GRASSES—(Normal Weight)—	
Western Rye Grass	14 lbs.
Brome Grass	14 lbs.
Timothy	48 lbs.
Kentucky Blue Grass	14 lbs.
Red Top (in chaff)	14 lbs.
Red Top (free from chaff)	30 lbs.
Meadow Fescue	22 lbs.
CLOVERS—	
Red or Mammoth	60 lbs.
Alsike	60 lbs.
White Dutch	60 lbs.
Sweet Clover	60 lbs.
ALFALFA	60 lbs.

FIG. 184.—*Estimating weight of hay in stacks.*

There is no accurate method of getting at the weight of hay in a stack except by weighing it, but several methods are employed for estimating the weight. All of these methods aim to get as accurately as possible the number of cubic feet in the stack. This is then divided by the number of cubic feet per ton of hay.

The following methods for estimating cubical contents of stacks are employed:

1. FOR OBLONG STACKS—
   Width of stack x length x overthrow x .31 = cubical contents of stack.
2. FOR ROUND STACKS—
   $\frac{\text{Circumference x circumference x 8 x}}{100}$ (height to slant plus 1/3 slant height of top) = cubical contents of stack.

The following table gives the approximate number of cubic feet per ton of prairie wool in stacks of different sizes and length of time standing:

Height of Stack	Length of time Standing	Number of cu. feet per ton
10 to 12 feet	30 days	613
10 to 12 feet	60 days	512
12 to 15 feet	30 days	512
12 to 15 feet	60 days	422
15 to 18 feet	30 days	422
18 to 20 feet	60 days or more	343

Alfalfa or rough slough grass stacked 30 to 60 days. . . 512 cu. ft.
Alfalfa or rough slough grass stacked over 60 days. . . 422 cu. ft.
Clover and timothy stacked over 30 days. . . . . 422 cu. ft.

FIG. 185.—*Average digestible Nutrients and Fertilizing Constituents in American Feeding Stuffs.*

(From "Feeds and Feeding", 16th Edition, by Henry and Morrison).

FEEDING STUFF	LBS. DIGESTIBLE NUTRIENTS IN 100 LBS.					LBS. FERTILIZING CONST'S IN 1000 LBS.		
	Dry Matter	Crude Protein	Carbo-hydrates	Fat	Total	Nitro-gen	Phos-phoric Acid	Potash
Concentrates—								
Wheat, spring	89.9	9.2	67.2	1.6	80.0	20.0	8.0	5.3
Durum wheat	89.6	11.0	61.2	1.6	78.8	22.0	8.6	5.2
Rye	90.6	9.9	68.4	1.2	81.0	18.9	7.3	5.7
Oats	90.8	9.7	52.1	3.8	70.4	10.8	8.1	5.6
Barley	90.7	9.0	66.8	1.6	79.4	18.4	8.5	7.1
Flax	90.8	20.6	17.0	29.0	......	36.2	15.0	9.5
Pea, field	90.8	19.0	55.8	0.6	76.2	36.0	8.4	10.1
Cured Corn—								
Corn stover, dry	90.6	2.2	47.8	1.0	52.2	9.4	4.5	12.9
Corn stover, medium in water	81.0	2.1	42.1	0.7	46.1	9.1	4.0	11.5
Corn stover, high in water	59.0	1.4	31.4	0.6	33.9	0.2	2.9	8.3
Hay from the Grasses—								
Blue Grass Kentucky, ripe	76.3	3.5	38.3	1.6	45.4	9.8	....	....
Brome grass	91.5	5.0	41.2	0.9	51.2	15.8	4.2	21.5
Fescue, meadow	88.3	3.5	45.2	1.1	51.2	10.9	4.6	17.2
Millet, common	85.7	5.0	46.0	1.8	55.0	13.3	3.0	21.5
Millet, hog	90.7	5.3	49.5	1.6	58.4	11.4	4.4	21.1
Oat grass	88.2	3.4	38.4	1.2	44.5	12.8	3.1	16.4
Prairie hay	93.5	4.0	41.4	1.1	47.9	12.8	....	....
Quack grass	94.1	4.2	49.7	1.1	50.4	11.7	....	....
Red top	90.2	4.6	45.9	1.2	53.2	11.8	4.4	18.8
Timothy	88.4	3.0	42.8	1.2	48.5	9.9	3.4	13.6
Wheat grass, common	92.7	4.0	44.0	.8	49.8	10.4	....	....
Wheat grasses, miscellaneous	93.6	4.4	44.7	.8	50.9	11.4	....	....
Wheat grass, western	94.1	4.2	50.5	.9	56.7	12.3	....	....
Wild oats	92.4	3.8	42.8	1.4	49.8	12.8	....	....

Hay from the smaller cereals—								
Barley hay, common	92.6	4.6	18.2	.9	51.8	11.2	......	......
Barley hay, bald	91.3	4.8	47.0	.9	53.8	11.8	......	......
Emmer hay	92.3	6.5	14.3	.9	52.8	16.0	......	......
Oat hay	88.0	4.5	38.1	1.7	40.4	13.4	8.0	32.7
Rye hay, all analyses	91.9	2.9	44.1	1.1	40.5	10.7	5.0	17.0
Rye hay, heading out, to in bloom	91.8	6.4	40.0	1.1	54.0	15.7	......	......
Wheat hay	91.9	4.0	48.5	0.8	54.3	9.9	......	......
Hay from the Legumes—								
Alfalfa, all analyses	91.4	10.6	39.0	0.9	51.6	23.8	5.4	22.3
Alfalfa leaves	93.4	15.8	35.1	1.3	53.8	36.0	......	......
Alfalfa stems	91.4	1.8	46.9	0.4	49.6	10.1	......	......
Clover, alsike	87.7	7.9	30.9	1.1	47.3	20.5	7.0	17.4
Clover, red	87.1	7.6	39.3	1.8	50.9	20.5	3.0	10.3
Clover, sweet, white	91.4	10.9	38.2	0.7	50.7	23.2	6.6	12.6
Clover, sweet, yellow	91.3	10.0	35.0	0.5	47.0	21.4		
Pea, field	88.9	12.2	40.1	1.9	50.0	21.2	6.7	12.4
Hay from Mixed Legumes and Grasses—								
Clover and Timothy	87.8	4.0	39.7	1.1	46.2	13.8	4.7	10.0
Peas and Oats	83.4	8.3	37.1	1.5	48.8	18.2	6.6	10.4
Straw and Chaff from the Cereals—								
Barley straw	85.8	0.9	40.2	0.6	42.5	5.0	1.8	12.0
Flax sheaves	92.8	5.8	25.2	3.0	37.8	11.5	1.9	10.5
Oat straw	88.5	1.0	42.6	0.9	45.6	5.8	2.1	15.0
Rye straw	92.9	0.7	39.6	0.4	41.2	4.8	2.8	7.9
Wheat straw	91.6	0.7	35.1	0.5	36.9	5.0	1.3	7.4
Wheat straw from rusted grain	91.0	2.0	33.3	0.1	36.2	13.9	......	......
Fresh Green Roughage—								
Corn fodder	21.9	1.0	12.8	0.4	14.7	3.0	1.1	3.7
Flint corn fodder in tassel	10.6	0.9	5.5	0.3	7.1	2.2	......	......
Fresh Green Grass—								
Bluegrass Kentucky	31.6	2.3	11.8	0.6	18.5	6.6	1.9	7.1
Brome grass, smooth	33.0	2.9	15.0	0.2	18.3	6.7	2.0	8.6
Fescue, meadow	30.5	1.6	15.0	0.5	17.7	4.8	1.8	7.0

Feeding Stuff	Lbs. Digestible Nutrients in 100 Lbs.					Lbs. Fertilizing Const's in 1000 Lbs.		
	Dry Matter	Crude Protein	Carbo-Hydrates	Fat	Total	Nitro-gen	Phos-phoric Acid	Potash
Millet, common	27.6	1.0	14.8	0.6	18.1	1.6	1.2	6.9
Millet, hog.	21.7	1.3	13.8	0.4	16.0	3.2	1.2	5.7
Oat grass, tall or meadow	30.3	1.1	13.3	0.4	15.3	4.2	1.8	8.4
Quack grass	25.0	2.2	11.3	0.7	15.1	6.4		......
Timothy, all analyses	37.5	1.5	19.3	0.6	22.2	5.0	1.8	6.7
Wheat grasses, miscellaneous	45.3	2.2	24.1	0.5	27.4	6.4		....
Wild oats....	36.6	1.5	18.7	0.7	21.8	4.2		......
Green Fodder from the smaller Cereals								
Barley fodder	23.2	2.3	11.5	0.4	14.7	5.4	1.3	6.8
Oat fodder..	26.1	2.3	11.8	0.8	15.9	5.4	1.8	7.7
Wheat fodder, all analyses	27.4	2.8	15.1	0.6	19.3	5.8	1.9	7.2
Green Legumes—								
Alfalfa, all analyses	25.3	3.3	10.4	0.4	14.6	7.2	1.5	6.7
Clover, alsike	21.3	2.7	11.8	0.4	15.4	6.6	1.8	9.2
Clover, red, all analyses	26.2	2.7	13.0	0.6	17.1	6.6	1.3	5.6
Clover, sweet	21.4	3.3	10.3	0.3	14.3	7.0	1.3	5.0
Peas, field, Canada.	16.6	2.9	7.4	0.3	10.7	5.8	1.1	2.8
Sanfoin...........	25.6	2.8	12.3	0.5	16.2	6.4	1.1	4.0
Vetch, hairy.........	18.4	3.5	8.4	0.4	12.5	6.7	1.4	5.4
Mixed Legumes and Grasses—								
Pease and Oats.	22.6	2.4	10.6	0.6	14.1	5.4	1.7	6.4
Vetch and Oats	26.5	2.8	13.3	0.4	17.0	6.4	1.6	6.3
Roots and Tubers—								3.2
Beet, sugar.	16.4	1.2	12.6	0.1	14.0	2.6	0.8	2.7
Carrot....	11.7	0.9	8.6	0.2	9.9	1.5	1.4	....

Mangel	9.1	0.8	6.4	0.1	7.1	2.2	0.1	2.2
Potato.	21.2	1.1	15.8	0.1	17.1	3.5	1.2	5.3
Rutabaga	10.9	1.0	7.7	0.3	9.1	1.0	1.2	5.0
Turnip.	9.5	1.0	6.0	0.2	7.1	2.2	1.3	2.9
Kohlrabi	9.0	1.7	5.6	0.1	7.5	3.2		
Rape.....	16.7	2.6	10.0	0.3	13.3	1.6	1.1	3.9
Turnip tops	15.0	1.8	7.3	0.1	9.3	1.5	1.5	5.2
Silage—								
Corn, well matured, recent analyses	26.3	1.1	15.0	0.7	17.7	3.1	1.6	1.1
Corn, immature	21.0	1.0	11.4	0.4	13.3	3.0	1.2	3.5
Corn from frosted corn	25.3	1.2	13.7	0.6	16.3	3.5	1.5	1.3
Corn from field-cured stover	19.6	0.5	9.9	0.4	11.3	2.2		
Miscellaneous Silage—								
Alfalfa.	21.6	1.2	7.8	0.6	10.4	5.6		
Corn and Rye	19.1	1.4	10.0	1.0	13.3	3.4		
Field Pea...	27.9	2.8	13.1	0.9	17.9	6.1	2.0	2.3
Oat...	28.3	1.5	13.8	0.9	17.3	3.2		
Oat and Pea	27.5	2.8	12.6	1.0	17.6	6.1		
Rye.	27.2	2.4	16.1	0.5	19.6	1.8	1.7	7.0
Barley	25.0	2.0	12.0	0.8	15.8	1.2	1.7	6.9